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RESEARCH MAN VS. ADMINISTRATOR—THE RESEARCH MAN'S VIEWPOINT[1]

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Before launching myself into the expected tirade of vituperative criticism of administrators in conservation, let me call on the World to witness my unhappy plight. The administrator who preceded me on this discussion panel is not just "an" administrator—he's my boss. The brass collar of servitude around my neck has his name engraved on it. The predicament calls to mind Eugene Field's review of a performance of the play *King Lear*, in which he wrote, "So-and-so played the King as though under constant apprehension that someone else was about to play the Ace." Nevertheless, this occasion provides a priceless opportunity to utter the suggestion that just possibly not all the failures in fish and game management are chargeable to incompetent biologists, and that advances may not have stemmed solely from the sapience of administrators.

In Michigan, of course, any conflict of thought or deed between administrators and researchers is unthinkable. My remarks will be confined to a purely academic analysis of conditions which, I have been told, exist now and then in less enlightened organizations.

In all seriousness, I honestly believe there is far less lack of harmony and understanding between the field-and-laboratory chap and the front-office magnate than there was ten or even five years ago. Partly, perhaps, because many of today's administrators were yesterday's researchers, but also because both classes of workers have had time to get accustomed to the fact that neither one can get very far without the other. In an ideally functioning conservation organization, the administrator's decisions are constantly being made wisely, soundly, and safely on the basis of a continuing flow of new and better dope from the research staff. The research man, on his part, is able to devote his full time to the pursuit of the facts so dear to him, without worrying his pretty little head over such crass details as budgets, popular support, or

[1] Contribution from the Michigan Institute for Fisheries Research.

This paper presents the approximate text of a talk delivered at a symposium which opened the Tenth Midwest Wildlife Conference, held at Ann Arbor, Michigan, December, 9–11, 1948. It was preceded by an address of welcome by President A. G. Ruthven, University of Michigan, and a talk, "The Commissioner Looks at Researchers," by the Hon. Harold Titus, Michigan Conservation Commission; and was followed by a paper, "Further Needs in Wildlife Research," by Dr. Clarence Cottam, Assistant Director, U. S. Fish and Wildlife Service.

political interference. It is only when one or the other, or both, deviate from this idyllic definition of function that frictions, frustrations, and recriminations arise.

In the research man's eyes, the greatest and least forgivable sin an administrator can commit is to announce some new policy, or even a supposed explanation of a biological phenomenon, on the basis of personal hunch or expediency, and to then direct his investigators to go out and get facts which will support his stand. Another aspect of the same sin is displayed by the administrator who inclines to suppress any findings of his investigative staff which run counter to his established policy. For the research man is basically an idealist; in a very real sense he is a dedicated man. If he were not, he'd be out selling life insurance and making a decent living. To him, the fact is the paramount goal, the open mind is the only proper attitude, and a ready willingness to admit mistakes and to revise policies is a sign of progress, not an admission of faulty judgment. The research man recognizes, as the administrator too often does not, that final, all-explaining facts are seldom learned—that his duty is to hew the path ever nearer, but that he will never reach the Ultimate Truth until he has joined the Choir Invisible. Hence he is the constant adversary of the *status quo*, a thorn in the side of those administrators whose goal is the speedy development of a management policy which will remain henceforth immutable and permit them to devote their declining years to the lining of their comfortable rut with plush while they bask in the applause of the multitude. The scientifically-trained conservation worker knows that policies must constantly change, in the light of new research findings and with changing conditions in nature, and he often wishes his administrative superiors were more adept in explaining the desirability of these changes to the unenlightened license-holders.

The conscientious administrator might be well advised to add up the figures, occasionally, and see for himself how much time his so-called research workers are actually spending on activities unimpeachably of a research character. As any given organization grows in size, red tape grows with it. Presently some super-clerk will have prepared a ponderous mimeographed manual of procedure which, with frequent additions and changes, becomes the bible of all personnel. Its paragraphs, sub-paragraphs, and serially numbered and dated changes cover every activity of every employee and prescribe suitable forms, to be filled out in quintuplicate, for every situation which may arise in the employee's normal routine. There exists in the minds of some research workers a low, nasty suspicion that the time is not far distant when the manual of procedure will also prescribe the sort of research they are to do, the manner and place in which they are to pursue it—and the conclusions they are to come up with, these latter to be in full and hearty accord with existing policy. Meanwhile, their days become increasingly filled with the ringing of typewriter bells and the rustle of manifold paper. Insensibly, they themselves become super-clerks—or sub-deputy administrators—and the research program languishes, buried

beneath the sterile paper-work of a full-blown bureaucracy. Admiral Halsey, in his recent memoirs, deplored the day when a typewriter was first permitted aboard a fighting ship. And conservation administrators might find it profitable to spend fifty cents for extra clerical help to save a dollar's worth of a research man's time, rather than *vice versa*.

One criticism which administrators habitually level at their investigators, and which causes the latter much anguish, is concerned with the research man's unwillingness to release conclusions until he has checked, re-checked, and re-rechecked his data. The administrator who honestly favors research is impatient to obtain sound facts on which to base his policies; the one who has formed or inherited an investigative staff grudgingly feels that by coercing a steady stream of reports, half-baked or otherwise, he is forcing his "theorists" to buckle down and be practical. Charles F. Kettering is credited with an anecdote, probably not wholly apocryphal, of the early days of the automobile, when two industrialists had climaxed a long and honorable career as wagon-makers by converting to the manufacture of horseless carriages, and, in keeping with such a progressive step, had splurged to the extent of adding a chemist to the payroll. About 10:00 a.m. of the chemist's first day on the job, one partner approached the other and remarked, "Let's go down and see what the new man's invented." The other replied, "Oh, he's new to the place, let's give him plenty of time. Let's wait till after lunch." The technical literature of conservation is cluttered with papers that should never have been published, but which were blasted out of insecure workers by administrators intent on getting "production" out of their staffs. Certainly many scientifically-trained workers tend to be overcautious, and require some pressure. The smart administrator is the one who senses when to turn on the heat and when to ease off.

Bosses, unfortunately, are in many respects just as human as the hired help, and prone to seek, under pressure, the quickest means of getting annoying or embarrassing problems off their necks. In conservation, this buckpassing most frequently takes the form of a damaging diversion of investigators from valuable research projects to trouble-shooting and hand-holding assignments. True, in the field of conservation, where support depends on backing from a notoriously fickle public, attention to gripes and hollers from the license-holders is imperative; a squeaking wheel that isn't promptly greased sometimes heats up and locks with apalling celerity, with disaster to passengers and pay-load alike. The research man is exasperated and frustrated almost beyond endurance, however, when the administrator who has been sending him hither and yon on such errands one morning calls him into the front office and with sober gravity asks for a report on the research project the wretched investigator hasn't been able to give two days' consecutive thought in the past six months. At the present time, almost every state and federal conservation organization has some sort of public relations branch. Many of these seem to function chiefly as propaganda-dispensing agencies. However, a hopeful note is seen in a few

places where people with enough technical training to understand the research projects under way are being added to the staffs of such information and education agencies, and it is to be hoped that further progress in this direction may result in much over-all improvement in public appreciation of the problems and practices of conservation, as well as in a desirable diversion of excessive public-relations work from research personnel. The possibilities of demonstration and extension-type approaches in selling conservation to the public are just beginning to be explored. There are available many technically-trained workers who, while lacking the flair for or interest in research, are admirably fitted to direct extension and demonstration activities.

"Here," the Red Queen said to Alice, "you have to run as hard as you can just to stay in the same place." Most game and fish biologists know what she meant. In conservation research it is almost impossible to stand still: one can go forward—or slip backward with astonishing rapidity. If, in response to any of a variety of all-too-well-known pressures, a given agency is forced to suspend or retrench its fact-finding program, even for a year or two, any subsequent attempt to restore it to its rightful position will require the expenditure of disproportionate effort and funds. Administrators are often subjected to pressure from biologically-illiterate laymen to quit spending money on research for five or ten years and just apply what is already known. Or at least, to refrain from supporting any research which, in the layman's eye, isn't of immediate and obvious practical advantage. How often, in the past, has the cart been at least three trace-lengths in front of the horse, in fish and game management projects! How many times has a public clamor for action—"Let's DO something"—induced administrators to channel the efforts of their staffs into superficial, hastily-conceived investigations which yield spotty, misleading information in the main, and only by the wildest and rarest stretches of inspiration and plain dumb luck pay off in findings of permanent, usable value. The damaging effects of such short-sighted practice not only place our endangered game and fish resources in continuing jeopardy, but increase distrust of research by the layman, who seldom discriminates between sound research and these expediency-dictated activities which are masqueraded unjustifiably under the name of research. Here is another source of profound irritation to the investigator—the growing tendency to divert significant proportions of research budgets to programs of essentially routine *management* character—without so informing the license-holders, thus permitting them to infer that they are contributing a much larger sum to research than is actually the case.

Administrators, be it acknowledged, are generally rather gifted men, and one of their greatest talents is that of leadership. They are men who speak with authority, and to whom people listen. I believe that many of them do not make sufficient use of their ability in keeping the public apprised of the fact that scientific conservation of fish and game is truly in its infancy; that, although its progress is remarkable in view of the minuscule amounts of time, men and money invested in it as com-

pared with medical, industrial, or agricultural research, it is just barely able to walk, and shouldn't be expected to fly for some time to come. They might point out to those skeptics who would suspend further research on fish and game and confine all efforts to applying the pitiful modicum of facts already pegged down, that similar practices in other fields would have us living in a considerably different world today; medical science would still be confined to "applying" the interesting discovery that the blood circulates through the body; automotive engineers would have called it a day once they'd invented the self-starter. In selling the public (and perhaps themselves) on the essential value of fundamental research as a basis for practical application, they might cite the example of the physicists, today's unquestioned aristocrats, who thirty years ago were considered the most impractical and unworldly of pure scientists.

And constantly they should harp on how little, actually, is known—how little, in fact, could possibly be known in view of the small amount of effort thus far invested and the peculiar nature of the problems. It is impossible to make frequent contacts with fishermen and hunters without being struck by the average layman's almost complete lack of comprehension of the inadequacy of our proven, factual information. Very often he has assumed that the answers are in the back of the book. He expresses keen astonishment when he is assured that the book hasn't even been written. With his proneness to confuse fact and folklore, he has most of the answers ready himself. He will inquire, with asperity, why his state conservation department should be supporting a study of, let us say, the life history of the brown trout. "Hell," he will say, "any damn fool knows that already." And he won't realize how true his profane restriction has made his statement. He has almost certainly never stopped to think that almost any field investigation of a fish, bird, or mammal, if it is to be successful, must cover a span of years sufficient to encompass at least one generation of the critter in question; and that several generations must be studied if cyclic patterns are to be clearly discerned, or effects noted of normally or abnormally changing environments.

There is perhaps no other field of human endeavor in which the lay public so freely arrogates to itself the privilege of passing judgment on accomplishments as in the field of wildlife conservation. The hunter or fisherman who has pursued his sport for twenty or thirty years rarely feels any hesitancy about stepping in and contradicting the professional man. He brusquely brushes aside the implications of findings long and laboriously accumulated by teams of sound, highly trained scientists if they do not coincide with his own prejudices—and it's just about as bad if they do, for then he's critical that time and money were spent to prove something that he, in his infinite wisdom, had known all along by hunch, osmosis, and divine revelation. It seems strange that the customers should so readily assume, on the basis of a long period spent as consumers, that they also are pre-eminently competent to dictate methods of production. Following that line of reasoning would lead to the conclusion that the best

physician is not the trained and duly certificated practitioner of medicine but the man who has been a life-long invalid; that the best automobile production chief is not the experienced engineer but the travelling salesman who needs a new car every six months; and that the man to consult when your affairs are in a legal snarl is not the practicing attorney but the man who has been run in by the cops every few months for the past ten years. This is not to say that the sportsman may not make worthwhile observations. Very frequently he does. But it is unusual indeed if he possesses enough collateral technical information, or subjects his observations to enough critical, objective scrutiny, to come up with the right management and production plan. After all, the sportsman approaches the pursuit of fish and game in a search for recreation. How much confidence would we have in the findings of a scientist if he entered his laboratory in a holiday mood, with a bottle of Old Tanglefoot on his hip, and remarked now and then to casual passers-by, "I just love to mess around with test-tubes and stuff—it's so relaxing."

My reason for considering the layman's attitude at some length is the fact that frequently it happens that such men are awarded policy-forming positions in conservation agencies. As a rule they have been quite successful in the business world, and have made a lot of money backing their hunches. There is a great deal of good that can be done by administrators with these abilities. But in the main, they will be well advised not to substitute their hunches for a research program. Trout and bass and deer and partridge are remarkably oblivious to applications of sound business psychology. On the other hand, men with outstanding executive ability can be of very great service to a conservation program if these abilities are directed at facilitating the work of the investigators and implementing it in the form of well-grounded management plans. And another point in favor of such men is their rather general possession of plenty of guts.

In this respect they contrast very favorably with a few conservation administrators—happily, fewer every year—who, when some of their staff are under fire from unenlightened pressure groups, hastily and spinelessly join with the critics in raising Cain with their subordinates in the hope of gaining cheap publicity and favor. In his notoriously underpaid status the research man is insecure enough without having to experience unreasoning sniping from both within and without the organization. It is natural that administrators should give heavy consideration to loyalty when rating their subordinates. But loyalty means little in an agency unless it works down, as well as up, the chain of command. It is an axiom in the military service that an officer who never lets his men down will, in his turn, never be let down by his men. Needless to say, the research man is human enough to respond favorably to flattering attention. He likes to think that the big boss knows something about what he's doing, and if the boss utters a word of praise or encouragement it's almost as heartening to him as the longed for dollar-per-year cost-of-living pay boost. It's a sorry sort of organization where the boss looks in on his subordinates only to bawl them out.

And another point of importance in considering the effect of administrator-investigator relations on organizational morale—when reports are published, it's awfully nice to know who really wrote them. Reports appearing simply under the name of the department or agency chief are annoying to the technical man. No doubt it greatly impresses the license-holder who may conclude, from the printed report, that Mr. J. Worthington Glutz, Chief of Fish and Game for the sovereign state of East Hypothetica, has found time during the busy biennium just past not only to say a few words at 1,057 sportsmen's club meetings and draw up blueprints for a new fish hatchery, but also to read 50,000 fish scales and analyze the contents of vast numbers of trout and partridge stomachs. It is important to research men to see their own names on reports they have written. It is important to them to have ready access to means for publishing their findings. They are sometimes criticized, and in some instances justly, for trying to build up big publication lists. But it should be understood that publications are the research man's only monument. He deals with intangibles, and his greatest pearls of wisdom are destined to be always anonymous in the eyes of the lay public. But he values the opinions of his colleagues, approbation and criticism alike. *It is only through publication that his research findings can be subjected to critical evaluation by the only men competent to judge them and to criticize them constructively.* And it is only through the constant operation of criticism and re-trial that progress can be maintained in investigational work. Administrators can win much favor with their biologist subordinates by establishing for their use regular publication series. Such publications will never enjoy the popular sale of a bosomy historical novel, but almost every copy will be read and criticized by an able man, and the net result to the administrator will be a body of well-verified facts reaching his hands sooner than if his staff worked alone and unaided. Not so long ago, there were conservation supervisors who were imbued with the old Scotch gamekeeper philosophy of secretiveness—of keeping all facts close hidden lest the fellow across the line in the next state see them and profit by them. This philosophy has no place in American conservation and is probably dead; but the surest guard against its resurgence in any quarter is an abundance of publication media.

Administrators are generally strong men, men of high personal ambition. When two such characters collide head on, or even find they are expected to pull toward a common goal together, dangerous antagonisms may arise. In the fang-and-claw world of private enterprise, such antagonisms and their carnivorous sequelae may be taken for granted. But in a service dedicated to the public welfare, it is disheartening indeed to see desirable interagency cooperation and coordination of effort hamstrung because the top men don't like each others' neckties. It is costly to the public and damaging to research interests when a number of empire-building administrators set up competing investigative agencies to work on the same, or nearly the same, problems—but from different headquarters, with different equipment. Just as the inefficiencies made obvious by the war

forced an attempt at unification of the armed services, so the demands of conservation problems require the close cooperation of interested agencies at all levels. There is no justification for the failure of a program when this failure stems from the petty personal jealousies and antagonisms of its top administrators.

Until now I have refrained from commenting at significant length on the effect of finances on the relations between administrators and their research staffs. Admittedly, the times we are now living in are chaotic, from the economic standpoint, and there are few who can prophesy the future with conviction. The scientist is by definition an impractical sort of fellow, far more interested in being able to work in his favored field than in amassing material competence. However, the scientist's family likes to eat.

For the biologist who has spent eight or ten years in college and university gaining the sort of training requisite for grappling with fish and game problems, only a few fields of endeavor are open. All are in public service; openings in private business or industry for such candidates are negligible. He can choose between teaching and applied work, and in the applied field between the various conservation agencies of the several states and of the federal government. In the depression years of the early thirties, when the establishment of conservation research staffs first gained headway, many a teacher of biology left off molding the plastic adolescent mind, and turned, with happy hosannas, to the new field. The change made sense to his practical-minded wife, too, for in those days conservation jobs paid better than teaching; recognition of the less secure nature of these jobs, of the shorter amount of vacation and leisure time, took the form of higher compensation. In recent years, however, research jobs in conservation have lagged far behind the procession of wage increases in other lines of endeavor. Today, a young man just completing his training is much more likely to turn to teaching than to a job with someone's conservation department, for now it will offer him more pay as well as greater security, professional prestige, and leisure for study or travel. Or, if he joins a conservation agency, economic necessity will drive him to seek, as rapidly as possible, appointment to an assignment of administrative character, that being the only other avenue for financial betterment open to him.

The net result of this situation so far as the administrator is concerned is that the bulk of the research on which he is to base his policies will be done by graduate students and immature, unseasoned investigators. I by no means minimize the value of the work done by such young men. Many of the fundamental facts of our profession were established by them. But much more rapid advances could be gained if competent research men could be held, and their growing abilities kept in the research field, not diverted into less productive but more gainful assignments. Can the administrators do something about it ?

THE EFFECTS ON FISH, BIRDS AND MAMMALS OF DDT USED IN THE CONTROL OF FOREST INSECTS IN IDAHO AND WYOMING

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Increasing use of DDT for destroying insects has aroused much interest in the effects of this poison on wildlife. Several observations have been made in the eastern United States (Cottam and Higgins, 1946; Nelson and Surber, 1947), but none has been reported in the forested areas of western United States. During May, 1947, 413,500 acres of forest were sprayed with DDT in oil solution to control an epidemic of tussock moth (*Hemerocampa pseudotsugata*) in northern Idaho. In July and August, four plots were sprayed in northwestern Wyoming in an experimental attempt to control mountain pine beetle (*Dendroctonus monticolae*). The spraying was done by airplane under the supervision of the Forest Service and the Bureau of Entomology and Plant Quarantine. These projects gave an opportunity to study the effects of DDT on the fish and wildlife.

In Idaho, forests in the western foothills of the Bitterroot Mountains near Moscow were sprayed at the rate of one pound of DDT per acre. The trees principally affected by the tussock moths were Douglas fir (*Pseudotsuga taxifolia*) and grand fir (*Abies grandis*). The vegetative habitat also included western white pine (*Pinus monticola*), ponderosa pine (*Pinus ponderosa*), western red cedar (*Thuja plicata*), lodgepole pine (*Pinus contorta*), and associated species. There was generally a heavy understory of several kinds of shrubs such as willow (*Salix* sp.), snowberry (*Symphoricarpos racemosus*), Oregon grape (*Odostemon aquifolium*), serviceberry (*Amelanchier alnifolia*), and Menziesia (*Menziesia ferruginea*). There were more than fifty streams in the treated area including the Palouse River, Potlatch Creek, Elk Creek, and their tributaries.

In Wyoming, four plots with a total area of 500 acres located in the Snake River Range were sprayed. Three plots were sprayed at the rate of five pounds of DDT per acre, and one was sprayed with seven and one-half pounds per acre. All plots were sprayed twice, July 22 and 23 and July 30 and 31, with one-half the total application of

[1] In cooperation with the Northern Rocky Mountain Forest and Range Experiment Station.

[2] Valuable assistance was given the project reported here by members of the U. S. Forest Service, U. S. Bureau of Entomology and Plant Quarantine, Idaho State Department of Fish and Game, and the University of Idaho. The following individuals from these agencies deserve special thanks: James C. Evenden, Dr. N. D. Wygant, Dr. C. H. Hoffman, K. E. Hungerford, Michael J. Throckmorton, Tim M. Vaughan and Hale Ebling. The assistance of O. J. Murie of the Wilderness Society is also acknowledged. J. P. Linduska, in charge, Chemical Control Investigations for the U. S. Fish and Wildlife Service, assisted in part of the field work and gave valuable suggestions in the preparation of the manuscript. Miss Viola Schantz, U. S. Fish and Wildlife Service, identified the small mammals.

DDT used at each spraying.

The principal forest cover was lodgepole pine with an admixture of quaking aspen (*Populus tremuloides*), Douglas fir and alpine fir (*Abies lasiocarpa*). The understory was usually sparse and was composed of shrubs such as willows, honeysuckle (*Lonicera* sp.), serviceberry and snowberry. Only one of the treated areas contained a stream large enough to produce fish.

FISH

Of more than fifty streams in the treated area in Idaho, forty were known to contain trout and eighteen were listed as fair to excellent fishing streams. Rainbow (*Salmo gairdnerii*), eastern brook (*Salvelinus fontinalis*), and cutthroat trout (*Salmo clarkii lewisi*) apparently were not affected by the DDT during the five weeks they were observed. Large populations of speckled dace (*Rhinichthys oscula carringtoni*), and redside shiner (*Richardsonius balteatus hydrophlox*) also appeared unaffected by the poison. Cottoids (*Cottus beldingii*), mountain suckers (*Pantosteus jordani*), and black bullheads (*Ameiurus melas*) suffered heavy losses in certain limited areas.

Most of the streams within the treated area were examined a day or two after they were sprayed, and many were re-examined later. One treated stream together with a comparable untreated stream was studied in detail. A few general observations are informative. Variations in the intensity of application of the DDT were caused by wind drift and other uncontrollable factors. In heavily treated areas most aquatic invertebrates were practically annihilated, except annelids and mollusks, which appeared to be unaffected. With light applications of DDT, surface Hemiptera and Coleoptera were killed. Of the bottom-dwelling larvae and nymphs, the Ephemerida and Coleoptera appeared to be more resistant (or less exposed) to light applications of DDT than the Plecoptera, Trichoptera or Diptera. These effects corresponded in general with those observed by Hoffman, *et al.* (1946).

Crayfish (*Astacus klamathensis*) were occasionally killed outright, but most of those affected were paralyzed for a considerable period. In Jerome Creek, with many beaver dams, and flowing less than ½ cubic foot per second, one crayfish was observed to be in a paralyzed condition during a period of two weeks. The final effect of the poison was not determined, but two months later six paralyzed crayfish and the disintegrated remains of many others were still in evidence in Jerome Creek. It seems unlikely that these specimens remained paralyzed for two months. Perhaps the poison became effective some time after exposure, or, less likely, rains may have washed additional quantities of DDT into the stream. There were no paralyzed crayfish in untreated stream sections having similar populations of this crustacean.

The effectiveness of DDT is dissipated rapidly in running water. Some evidence of the rapidity of dissipation was provided by studying the distribution of surface Hemiptera downstream from treated areas. These ubiquitous insects are especially susceptible to the poison, so their presence can be used as an indication that the DDT is not present in lethal quantities. Several observations for as long as two weeks

after spraying resulted in a negative count of surface Hemiptera for distances approaching one mile downstream from the treated areas. These observations were made on fast-flowing streams. The effective distance may be less in slow-moving streams containing an abundance of aquatic vegetation.

In stream sections subject to severe poisoning, and the loss of virtually all bottom organisms, there was a pronounced increase in the growth of algae. On some riffles the growth formed a tight blanket over the rubble. Streams well removed from the treatment areas were examined to confirm the fact that this algal growth was a result of poisoning and not a normal seasonal occurrence.

In addition to the foregoing general observations, certain quantitative effects of the DDT were measured. Meadow Creek, a tributary of the Palouse River, and Charlie Creek, a tributary of the St. Maries River, were selected for comparative studies of food organisms under DDT treatment. The streams are six miles apart, the former within the treated area and the latter outside. Similar riffles in these two streams were sampled with a standard square-foot bottom sampler. The results are shown on Table 1.

TABLE 1.—RIFFLE ORGANISMS PER SQUARE FOOT AT LOWER STATION, MEADOW CREEK, AND AT CONTROL RIFFLE, CHARLIE CREEK. SECTIONS OF MEADOW CREEK TREATED WITH DDT ON MAY 22 AND 24

Forms	Meadow Creek Treated Area				Charlie Creek Untreated Area			
	May 21 (2)[1]	June 5 (3)	June 27 (1)	July 28 (1)	May 24 (3)	June 5 (2)	June 27 (1)	July 28 (1)
Ephemerida	51		1	31[2]	43	39	69	154[2]
Plecoptera	3				5	13	7	16
Trichoptera	5				4	3	2	7
Coleoptera:								
adult	4	1		2	7	5	5	3
larvae					3	2		
Diptera:								
Simulidae	20				7	2	4	2
Chironomidae								
Tabanidae							1	
Tipulidae	1				2	1		6
Hydracarina			1	5	1			
Annelida								
Oligochaeta		2		9	1	2		8
Hirudinea								
Planaria								
Nematoda						1		
Crustacea[3]			1					
Margaritanidae					1			

[1] Number of square foot bottom samples averaged. Fractions listed as units.
[2] Largely new hatch.
[3] *Astacus klamathensis.*

The first column shows the average number of organisms in two samples taken the day before Meadow Creek was poisoned. The other three columns show average counts from the same riffles at later dates. In the fourth column is the first evidence of recovery

—a hatch of mayflies in July. The decline of food organisms in Meadow Creek is in striking contrast to the stable population in Charlie Creek.

Table 2 shows the marked decline in food organisms that occurred after spraying at three stations in Meadow Creek. The upper and lower stations were approximately five miles apart, with the middle station about half way between the others.

TABLE 2.—RIFFLE ORGANISMS PER SQUARE FOOT BEFORE AND AFTER DDT APPLICATION, MEADOW CREEK AND WEST FORK, PALOUSE RIVER, IDAHO

Forms	Lower Station							Middle Station					Upper Station					
	Before		After					Before			After		Before				After	
	May 21		June 5			June 27	July 28	May 21			June 5		May 21				June 9	
	A	B	A	B	C	A	A	A	B	C	A	B	A	B	C	D	A	B
Ephemerida	41	62				1	31[1]	25	20	10			30	42	84	62	5	
Plecoptera	5	1											2	1	5	4		
Trichoptera	6	4						3	1	5			2	5	8	5		
Coleoptera:																		
adult	3	5		1			2		2				2	1	11	2		
larvae																		
Diptera:																		
Simulidae, Chironomidae	25	16						24	13	2					5	2		
Tabanidae																	1	
Tipulidae	1																	
Hydracarina						1	5											
Annelida:																		
Oligochaeta		1	2	1	2		9			10	3	2	4	9		2	10	8
Hirudinea									1			1						
Planaria														1				
Nematoda											1			1				
Crustacea[2]						1		1						1			1	1
Hemiptera																	1	
Cyprinidae[3]																	10	80

[1] Two specimens of pretreatment age, remainder newly hatched.
[2] *Astacus klamathensis.*
[3] Alevins, probably dace.

As surface food constitutes a considerable portion of the trout diet during the spring and summer months, an effort was made to determine the reduction in aerial forms that contribute to the surface food supply. Table 3 shows the results of sampling with six ½-square foot sheets of flypaper immediately before and after the application of DDT. Sheets were pinned to logs and tree trunks in vertical position and as close to the water surface as possible. Both sets of sheets were placed in the same locations. The decline in aerial insects after spraying was virtually complete.

Several changes in the fish's diets resulted from the effect of the DDT on the food-organisms. This is reflected in the contents of 72 trout stomachs collected before and after the DDT was applied. The first group of 37 stomachs was collected before DDT was applied or from streams outside the treatment area. The second group, 35 stomachs, was from DDT-treated streams. The percentage composition of 43 of the stomachs, analyzed by Mr. Tim Vaughan, was based on dry weights. Percentage composition of the others was determined by the liquid displacement of the drained specimens in a calibrated centrifuge tube.

The most striking influence of the DDT on the fish's diet was the marked increase in crayfish after spraying. There were no crayfish in the stomachs

from untreated streams, although these streams were observed to contain populations of crayfish similar to those of the treated streams. Four of the six lots of fish caught after spraying contained crayfish, The percentages of crayfish in these six lots of stomachs were:

4 brook trout —21.0 per cent
21 brook trout —99.2 per cent
1 brook trout —44.4 per cent
3 rainbow trout—42.0 per cent
2 rainbow trout— 0.0 per cent
4 rainbow trout— 0.0 per cent

Crayfish were the only item that increased in the percentage composition of stomach contents from sprayed streams. All other food items decreased in the percentage composition. May flies and caddis flies were not present in stomachs collected after spraying, although they frequently occurred in stomachs taken before spraying.

The amount of food in the stomachs of fish from DDT-treated waters was not significantly less than that from untreated waters, according to "Student's" t-test. The great number of readily available paralyzed crayfish compensated for the decrease in other forms. However, it is probable that the supply of crayfish became depleted before the streams became repopulated with the normal food organisms. This would have created a food shortage some time after the spraying. Hoffman, *et al.* (1946) found that the repopulation of some aquatic forms may not occur for a year or more after the application of DDT. For this reason investigations concerning effects on fish life should include sampling repetition to detect possible delayed effects.

TABLE 3.—AERIAL AND TERRESTRIAL FORMS TRAPPED ON FLYPAPER EXPOSED VERTICALLY AT SCATTERED POINTS NEAR SURFACE OF WEST FORK MEADOW CREEK. EACH SHEET = ½ SQUARE FOOT OF ADHESIVE SURFACE

	Before DDT applications Six sheets exposed 68 hours						After DDT application Six sheets exposed 76 hours					
	A	B	C	D	E	F	A	B	C	D	E	F
Ephemerida					3	4						
Plecoptera		4	4	3		2						
Trichoptera	6	14	3	1	9	17						
Coleoptera				1	2	3						
Lepidoptera		1										
Hymenoptera[1]			1			7					1	
Hemiptera[2]				2								
Diptera:[3]												
Large	1	2	1	3	4	2						1
Small	20	20	11	25	26	16	2		1	2	2	
Arachnida		1		4		1				1		

[1] Includes 4 ants.
[2] Aphids.
[3] Large: tipulid, tabanid, muscid, etc.,
Small: culicid, chironomid, simulid, etc.

Fish studies in Wyoming were concerned with a population of cutthroat trout in Rock Creek, a small stream bordering Spray Plot No. 3, Although the flow measured only 0.7 cubic feet per second, the channel was blocked by beaver dams forming thirty-four ponds which contained a surprisingly

large population of trout. The stream received the first application of DDT (2½ pounds per acre), but the second application missed Rock Creek, with the possible exception of a light drift which may have been deposited on some parts of the stream. Nine dead trout were found the day after the first spraying, two the next day, and one the second day after the second spraying.

Following the first spraying, increased feeding activity of the trout was noted. This was reflected in stomach samples. Thirty-two stomachs collected two days before spraying contained an average volume of 0.43 c.c. Stomachs of the eleven dead trout found after spraying contained an average of 1.67 c.c. Fifteen stomachs collected two days after spraying contained only 0.24 c.c. The latter stomachs contained fewer insects and more amphipods than the stomachs collected before spraying.

A marked reduction in riffle organisms occurred after spraying, but appreciable numbers survived. The latter included forms especially susceptible to DDT poisoning, such as insect larvae and nymphs. The downstream effect of the DDT apparently was not felt beyond the mouth of Rock Creek, which flows into Fall Creek less than 100 yards below the treated area. There was no measurable loss of organisms on a riffle in Fall Creek immediately below the mouth of the tributary stream.

BIRDS

In Idaho the effects of DDT on birds was measured by comparing bird populations on two study-plots, one inside and one outside the treated area. The treated study-plot was 20 acres (ten chains by 20 chains) in size and located near Harvard in a forest composed largely of Douglas-fir, with ponderosa pine, lodgepole pine and other associated species. The control plot was necessarily located outside the area of Douglas-fir dominance because all areas bearing the latter species were sprayed. However, 85 per cent of the species of birds on the treated plot occurred also on the control plot, so the two populations were comparable. The control plot was irregular in slope and contained approximately 20 acres. The forest was composed predominantly of western red cedar.

Bird populations were censused by the territory mapping technique (Williams, 1936). The treated plot contained a population of 436 breeding pairs before spraying and 394 pairs after spraying, a decrease of 9.5 per cent. The control plot contained 376 pairs in the first period and 336 pairs in the second period, a decrease of 10.6 per cent. The similarity in population trends on both the treated and untreated plots apparently indicates that spraying had no immediate effect on the populations and that the decreases were probably attributable to causes other than DDT. Many nests, family groups, and individual birds were observed during the study. None of these seemed to be affected by DDT.

In Wyoming, it was too late in the season to use the territory mapping technique. Most nesting activities were completed, and individuals and groups of birds were moving erratically about the areas. However, an index to populations was obtained by making timed counts over measured distances in the

study plots. Three plots of about 10 acres each were studied. Plot 1 was in the center of the area to be treated with 7½ pounds of DDT per acre. Plot 4 was in the center of an area to be treated with 5 pounds per acre, and the third was an untreated control plot.

droica petechia), and one unidentified bird (song sparrow?).

Of special interest is the fact that two families of ruffed grouse (*Bonasa umbellus*) on Plot 4 survived both sprayings. One family included five young, the other three young.

TABLE 4.—STRIP COUNTS OF BIRDS ON THREE PLOTS IN WYOMING

Period of Counting	Plot 1 (7½ lbs.)			Plot 4 (5 lbs.)			Control Plot		
	Before Spraying	After 1st Spraying	After 2d Spraying	Before Spraying	After 1st Spraying	After 2d Spraying	Before Spraying	After 1st Spraying	After 2d Spraying
No. of times counts were made	4	4	3	3	4	4	2	3	3
Total no. of birds observed	69	51	21	81	115	99	28	70	40
Per cent of Changes		*−26*	*−70*		*+42*	*+22*		*+150*	*+43*

The figures in Table 4 suggest that the DDT may have caused a decrease in population of birds on Plot 1, and may have partially suppressed a normal increase on Plot 4, as compared with the great population increase on the control plot. Further evidence that the DDT affected the bird populations is furnished by the finding of dead or dying birds on the treated areas. These birds showed symptoms of DDT poisoning, such as tremors and incoordination before they died. Five such birds were found on Plot 1 (3 pink-sided juncos, *Junco mearnsi*, one mountain chickadee, *Parus gambeli*, and one *Empidonax* flycatcher). Two pink-sided juncos were found on Plot 4. No affected birds were found on the control plot. Three affected birds were found on Area 3 (5-pound-per-acre treatment), a robin (*Turdus migratorius*), a yellow warbler (*Den-*

MAMMALS

In Idaho two study plots were established, one near the center, and one at the edge of the largest single area to be sprayed. The effects of DDT on mammals were observed both by direct field observations and by live trapping. Five species of mammals were trapped before, during and after spraying to determine population trends in relation to the spraying. The animals trapped were chipmunks (*Eutamias ruficaudus simulans* and *E. amoenus luteiventris*), white-footed mice (*Peromyscus maniculatus artemesiae*), red-backed mice (*Clethrionomys gapperi saturatus*), and jumping mice (*Zapus princeps*), in that order of frequency. No decreases in populations were apparent that could not be properly accounted for by causes other than DDT poisoning. Direct observations

of the animals trapped as well as pine squirrels (*Tamiasciurus hudsonicus*), Columbian ground squirrels (*Citellus columbianus*), pocket gophers (*Thomomys talpoides*), black bears (*Euarctos americanus*), and white-tailed deer (*Odocoileus virginianus*) revealed no symptoms of DDT poisoning or evidence of deaths caused by the poison.

In Wyoming the three plots used in the bird study were also used for the live-trapping and direct observations of mammals. The animals trapped and observed were red-backed mice, field mice (*Microtus longicaudus*), white-footed mice, jumping mice, chipmunks (*E. a luteiventris*) and pine squirrels.

The results of trapping showed no significant decrease in populations following spraying. Two species of mammals showed symptoms that may have resulted from DDT poisoning. Chipmunks with tremors were observed, but there were relatively few of them affected. It was not definitely established if the symptoms resulted from DDT poisoning. A shrew (*Sorex palustris navigator*) showed typical symptoms of DDT poisoning.

DISCUSSION

Different species of the three classes of vertebrates studied with reference to forest insect control with DDT, showed varying degrees of susceptibility to the toxicant. In general, susceptibility was highest for fish, less for birds, and least for mammals. Some fish succumbed to aerial applications of one pound per acre, while the mammals showed resistance to doses as great as 7½ pounds per acre. Within each class there was also considerable interspecific variation in susceptibility. In Idaho, for instance, cottoids, mountain suckers and black bullheads succumbed to relatively light doses of DDT while speckled dace, redside shiners and three species of trout showed no adverse effects. In Wyoming, individual variation in response to the poison was demonstrated by cutthroat trout. Some individuals of this species were killed while others in the same pools lived. It is also significant that these trout withstood the one-pound-per-acre dose in Idaho but were adversely affected by 2½ pounds per acre in Wyoming. The kill of important fish food items was heavy even at the application rate of one pound per acre.

Birds apparently were not affected by the one-pound dosage of DDT in Idaho. In this respect our findings agree with those of Hotchkiss and Pough (1946) and Kendeigh (1947) who made comparable studies in Pennsylvania and Ontario, Canada. Dosages of 2½ to 7½ pounds per acre in Wyoming showed definite, though relatively slight effects on the bird population. Studies elsewhere (Hotchkiss and Pough, 1946; Stewart *et al.* 1946; George and Stickel 1947) have shown, however, that under some conditions these higher amounts of DDT may be critical for bird populations. The nominal mortality found in our study may indicate that birds not confined to nesting territories are less susceptible to DDT poisoning. However, there is need for verification of this hypothesis by more intensive studies than present facilities allowed.

The number of affected birds was too small to furnish much evidence as to inter-specific variations. Juncos were killed more abundantly than other species, but they were also the most

common species on the study plots. Woodpeckers, which were also common in the Wyoming project, were not affected by even the heaviest application of 7½ pounds per acre. Since the boles of trees receive less spray than either the forest canopy or ground surface, it would be expected that birds with habits like those of woodpeckers would have limited feeding and body contact with the poison.

The evidence gathered from the study of mammals indicates that, in general, DDT where applied aerially in amounts up to 7½ pounds per acre has little, if any, direct effect on this class of animals. A possible exception to this is chipmunks and shrews which may be slightly susceptible to the heavier doses of the poison.

This study as well as others has shown that DDT in the amount of one pound per acre for forest insect control causes no appreciable direct effect on fish. In the case of birds and mammals, it appears that dosages in excess of 2 pounds per acre are required to produce direct toxic effects. However, anyone who has witnessed the considerable reduction of invertebrate animals in such operations is impressed with the possible indirect effects. The limited time and personnel available for this project prevented the detailed analysis of these indirect effects.

As nearly as could be determined, the marked reduction of insect food items was of no immediate concern to any of the major vertebrate groups. In the case of fish, however, conspicuous changes in the diet were observed.

Recent studies have suggested that wildlife effects may result from such operations even though the insecticide applications involve amounts well below the direct toxic level for vertebrates. Couch (1946) found that the diet of raccoons was greatly modified following a heavy kill-off of key invertebrate food items by a comparatively small dosage of DDT. Some birds also left the area under observation by Couch, an effect which he assumed to be due to a reduction in food supply. It has been observed in the field that birds may consume with impunity large numbers of DDT-killed insects in forest areas of one pound per acre spraying. However, it has recently been demonstrated in the laboratory that such a diet may prove critical to songbirds if followed by a short period of partial starvation (George and Mitchell, 1947). Since such a development could readily occur in the field it represents another possible indirect effect that might not reveal itself in a casual, survey-type of study. In view of such observations it seems prudent to continue to deal circumspectly with study results of the type presented here, and to encourage detailed studies of programs involving wide scale use of such toxicants.

SUMMARY

In connection with projects for forest insect control in Idaho and Wyoming, the effects of DDT on the fish, birds and mammals were studied by direct field observations and by censuses to determine population trends.

In Idaho some cottoids, mountain suckers and black bullheads were killed by DDT, but speckled dace, redside shiners and three species of trout were apparently unharmed. Birds and mammals apparently were not adversely affected by the application of one pound per acre.

In Wyoming several cutthroat trout were killed by DDT applied at the rate of 2½ pounds per acre. These represented only a small per cent of the total population. A few birds were killed with experimental application rates of 2½ to 7½ pounds per acre. Mammals were unaffected, with the possible exception of a few chipmunks and a shrew which showed symptoms possibly resulting from DDT.

In both states, great amounts of invertebrate food organisms were killed. This apparently had no immediate effect on the terrestrial vertebrates, but in aquatic situations a conspicuous removal of food items caused changes in the diet of the fishes.

Susceptibility to DDT poisoning appears to be greater in the lower vertebrates and lesser in the higher vertebrates. There is marked specific and individual variation in susceptibility to the poison.

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WILD TURKEY FOODS IN WEST VIRGINIA

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With the beginning of the 1944 fiscal year, the West Virginia Conservation Commission started its wild turkey investigation. It was the Commission's desire to obtain pertinent information concerning the present distribution and status of the Eastern Wild Turkey (*Meleagris gallopavo silvestris* Vieillot). This study embraces one phase of the investigation and gives in detail the results of an analysis of 4,299 droppings collected during the 1946–47 fiscal year.

The workers are deeply indebted to the U. S. Fish and Wildlife Service staff at the Patuxent Research Refuge Laboratory, Laurel, Maryland for their assistance in identification of unknowns and for the facilities they so graciously offered during the laboratory analysis of the droppings. Particular indebtedness is due Dr. A. C. Martin for his cheerful guidance and aid. James S. Lindzey, Wendell G. Swank, R. M. Bean, Henry Perkins, and Raymond Hawse of the West Virginia Conservation Commission assisted in collecting the fecal material. This study was carried on in conjunction with West Virginia Pittman-Robertson project 12-R under the supervision of Director Jack K. Shipman, and W. R. DeGarmo, Chief Game Technician.

According to Bent (1932) the original range of the wild turkey extended from Maine and Ontario southward and westward. The present range extends from central Pennsylvania west to Missouri, south through eastern Louisiana, and east to the Atlantic (from Mosby and Handley, 1943). In West Virginia the occupied range includes the 21 eastern counties in the rugged, mountainous region. Two fundamental types of vegetative cover are found here: oak-hickory-pine forest and beech-birch-maple-hemlock forest. Approximately 3,024,523 acres of land in West Virginia now support a wild turkey population with 56 per cent resident in the beech-birch-maple-hemlock type.

The analysis of droppings in studying the food habits of gallinaceous birds is not new. Dalke (1935) used this method to study the foods of the Ring-necked pheasant (*Phasianus colchicus torquatus*) and Dalke, Clark, and Korschgen(1942) used the same method for analyzing wild turkey foods as did Kozicky (1942) in Pennsylvania. In 1936 Wilson and Vaughn reported on the use of fecal samples for a study of Bobwhite quail (*Colinus virginianus virginianus*) foods. The dropping analysis method also was used by Swanson (1940) for studying the food habits of the Sharp-tailed grouse (*Pedioecetes phasianellus*).

Most of the past food habits studies have been based upon observation records and the contents from crops and gizzards. The use of fecal material for food habits analysis is not recommended here as a substitute for the crop and

gizzard analysis methods but rather as an additional aid. Dropping analyses have several disadvantages: (1) food item identification is often difficult; (2) those items which are most palatable and most easily assimilated, often occur in relatively small amounts in the droppings; (3) considerable time is required to collect the samples; and (4) many people rebel at the thought of collecting fecal samples, hence little outside cooperation can be expected. Several advantages largely offset the difficulties encountered: (1) the bird is not destroyed, (2) large samples can be collected when the habits of the bird are known, and (3) samples can be obtained at all seasons.

No previous studies have been made of wild turkey foods in West Virginia. Bennett and English (1941) in nearby Pennsylvania reported on the contents of 14 crops secured during the November hunting season. Cultivated grains were the most important, forming 62.6 per cent of the total volume. Other major food items were acorns, grasses, wild grape, and wild cherry. An investigation in Pennsylvania by Kozicky (1942), revealed that acorns, grasses

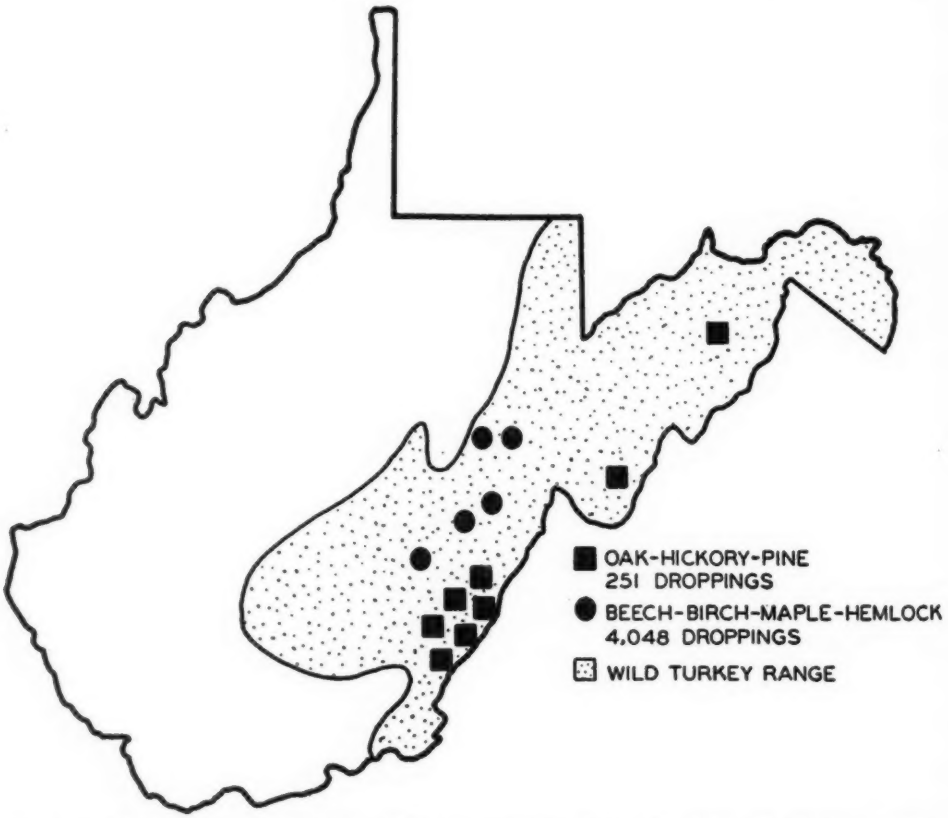

FIG. 1.—Distribution of dropping collection areas on West Virginia wild turkey range.

and sedges, wild grapes, dogwood, wild cherry, and snails were taken throughout the year. Mosby and Handley (1943) consolidated all available information on turkey food habits in the neighboring state of Virginia and from their analysis of 524 stomachs, they found acorns, dogwood, wild grape, and corn to form 53.97 per cent of the total diet. Our analysis revealed somewhat different results because of the severe winter conditions.

Droppings were collected for this study along with the performance of other field duties. They were placed in 3×5 inch envelopes labeled as to locality, county, and date. At the end of each day they were dried and filed in insect-proof containers. Later the entire collection was analyzed in the laboratory. A macroscopic examination of the droppings in the field revealed the general trend of the food types and proved to be an aid to identification in the final analysis.

TABLE 1.—FOOD ITEMS IDENTIFIED IN 4,249 WILD TURKEY DROPPINGS COLLECTED FROM JULY, 1946 TO APRIL, 1947 ON WILD TURKEY RANGE IN WEST VIRGINIA

Kind of Food	Frequency	% Total Volume
Vegetable Matter		98.32
Oats (*Avena sativa*)	1,190	21.46
Corn (*Zea mays*)	1,569	16.23
Grasses (*Poa, Danthonia, Muhlenbergia, Digitaria, Festuca, Setaria*)	1,319	12.30
Beechnuts (*Fagus grandifolia*)	748	11.05
Beechbuds	881	9.90
Ferns (*Pteridophyta*)	1,079	9.72
Hemlock Needles (*Tsuga canadensis*)	384	3.66
Bryophytes (mostly *Lycopodium*)	303	3.19
Wild Grape (*Vitis* sp.)	176	2.80
Dogwood (*Cornus florida* and *C. amomum*)	697	2.20
Blackberry (*Rubus* sp.)	625	2.14
Wild Cherry (*Prunus* sp.)	315	.96
Wild Raisin (*Viburnum* sp.)	209	.93
Wild Indigo (*Baptisia tinctoria*)	164	.66
Greenbrier (*Smilax* sp.)	163	.31
Hawthorn (*Crataegus* sp.)	154	tr.
Smartweed (*Polygonum* sp.)	152	tr.
Witch hazel (*Hamamelis virginiana*)	108	tr.
Wild rose (*Rosa* sp.)	74	tr.
Birchbuds (*Betula* sp.)	31	tr.
Partridgeberry (*Mitchella repens*)	29	tr.
Animal Matter		1.60
Beetles (*Coleoptera*)	240	tr.
Stink bugs (*Pentatomidae*)	73	tr.
Insect cocoons	12	tr.
Ants, Wasps (*Hymenoptera*)	10	tr.
Millipedes (*Diplopoda*)	8	tr.
Grasshoppers (*Locustidae*)	6	tr.

For purposes of general food habits it is desirable to study droppings from as many different turkey flocks as possible. The foods of approximately 32 different turkey flocks comprising more than 5 per cent of the total turkey population in West Virginia are presented (Table 1). The fecal samples were collected from Pocahontas (2,339), Randolph (1,706), Hampshire (175), Hardy (17), Pendleton (8), and

Greenbrier (29) counties (Figure 1) for all months except August, 1946 and May and June, 1947. The bulk of the material was collected during the winter months of January (472), February (467), March (2,038), and April (1,168). Information concerning the diet of the birds during the critical food season in the winter was deemed of major importance. The 1946–47 winter in West Virginia was severe and imposed undue hardships upon the turkeys.

We have attempted to answer the question, "What do turkeys eat when two or more feet of snow cover the ground?". Mild weather prevailed until about the middle of January. From then until the first part of April, the mountain regions of West Virginia were covered with snow from two to fifty-two inches deep and temperatures often were near zero. The general food supply for turkeys was considered poor over most of the range because only a few acrons were produced by the oaks (*Quercus borealis*, *Q. alba*, and *Q. velutina*) and the beech (*Fagus grandifolia*) crop was fair but characteristically "spotty." Black cherry (*Prunus serotina*), dogwood (*Cornus florida* and *C. amomum*), witch hazel (*Hamamelis virginiana*), and greenbrier (*Smilax* sp.) yielded an abundant supply of food and their importance was borne out in the analysis.

The laboratory procedure used in this analysis was commensurate with that described by the U. S. Fish and Wildlife Service in Wildlife Leaflet 222 (June, 1942). Each dropping was examined individually and considered as a single unit. The dry dropping was crushed by rolling it between the fingers or in those cases where it was not easily broken in this manner, it was pulverized with a mortar and pestle. Next the material was separated into its various components and examined under a binocular microscope. The per cent of total volume of the food items was determined by ocular comparison and estimated to the nearest whole number. Items less than 1 per cent were considered as traces. Percentages based upon the frequency of occurrence are generally considered the more accurate method of tabulation for droppings and were used in this study. Separation of food items completely to obtain a volumetric measurement, as in crop and gizzard analyses, was obviously impractical. Results of the analysis for each dropping were tabulated on 3×5 inch filing cards.

Both of the "wet" methods used by Dalke, Clark, and Korschgen (1942) and Kozicky (1942) were too involved, time consuming, and messy, but good results were obtained, especially in droppings containing insect material. The factors on the credit side of the ledger for the "dry," individual, dropping-analysis method are accuracy and speed, two points of importance to all food habits investigators. It might be added here that a binocular microscope with 10×, 20×, and 30× objectives is desirable and that it is absolutely necessary to have a complete reference collection of the flora and fauna from the study area.

ANALYSIS

Vegetable matter made up 98.32 per cent of the total volume of food represented, the remainder (1.6 per cent) being animal, principally insect. The major portion of the vegetable matter

was composed of fruits, seeds, leaves, and buds with a total of 58 food items identified. The small number of food items found in the winter droppings was due to the small variety of foods available at that season. Oats formed the largest total volume but was surpassed in frequency by corn. The other important foods were grasses, beechnuts, ferns, hemlock leaves, bryophytes, wild grape, dogwood, black berry, and wild cherry. These latter items constituted 57.92 per cent of the total volume and probably would have been the diet of the turkeys had not emergency winter feeding been practiced. Acorns were not an important food item due to a general failure of the mast crop. Unidentifiable items were listed as unknowns. The average volume of a dropping as determined from the measurement of 150 droppings was 10.27 cubic centimeters.

PLANT FOOD

Emergency winter feeding played an important part in the turkey diet as shown by the frequency of corn (1,569) and oats (1,190). The scattering of artificial feed was practiced only after there had been two weeks of continuous snowcover over 12 inches deep. It was unlikely that the turkeys obtained corn or oats from farm fields as there were few dwellings and cultivated areas on the turkey range. About 90 per cent of the corn seemed to be utilized physiologically. Oats, on the other hand, were utilized only about 40 per cent and much of the hard seed coat remained in the fecal passage.

Grasses occurred in every month covered by the analysis and were among the three most important foods for each month except April (Figure 2). Blue grass (*Poa*) constituted the major portion of those identified, with wild oat grass (*Dantthonia*), muhly grass (*Muhlenbergia*), finger grass (*Digitaria*), and foxtail (*Setaria*) occurring less commonly. The leaves of grasses rated high in palatability but only a few

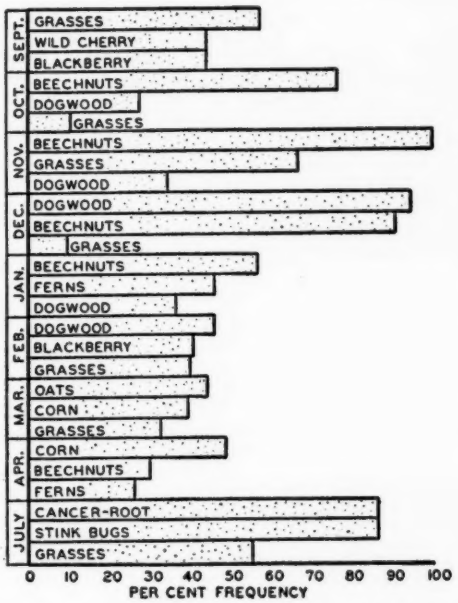

FIG. 2.—Three most important wild turkey foods for each month as determined from an analysis of 4,249 droppings.

seeds were found. When there was no snow on the ground the turkeys obtained the grass from fields, roads, and trails, but during the winter it was eaten when the flocks were feeding along streams and around permanent springs. Grass probably provided certain vitamins and other substances. However, it was not digested to any great extent and was easily identified from the other food items.

As shown in Figure 2, the beechnuts

were of major importance from October to January but were still attractive as late as April. The depth of the winter snow affected the availability of the beechnuts. On several occasions the turkeys had scratched through snow 12 inches deep to obtain this preferred food but seldom were the birds able to feed on the beechnuts when the snow was deeper. Only the hard, outer seed coat and an oily residue of the beechnuts remained in the dropping, indicating that about 95 per cent of the nut was utilized. For the most part beech occurred only at the higher elevations in West Virginia and therefore was not represented in the food items listed from the lower oak-hickory-pine range (Table 2).

TABLE 2.—MOST IMPORTANT PLANT AND ANIMAL FOODS IN THE TWO HABITAT TYPES FOUND ON THE WILD TURKEY RANGE OF WEST VIRGINIA

Beech—Birch—Maple—Hemlock		Oak—Hickory—Pine	
Kind of Food	Per Cent Frequency	Kind of Food	Per Cent Frequency
Vegetable		*Vegetable*	
Corn	38.9	Dogwood	71.7
Grasses	29.4	Wild Grape	62.1
Oats	29.2	Grasses	52.9
Ferns	26.5	Oats	7.9
Beechbuds	21.9	Ferns	6.7
Beechnuts	18.7	Corn	5.6
Dogwood	16.9	Wild Raisin	5.2
Blackberry	15.4	Fingergrass	3.9
Wild Cherry	10.1	Wild Indigo	3.6
Hemlock Needles	9.6	Greenbrier	3.2
Animal		*Animal*	
Beetles	4.3	Beetles	13.1
True Bugs (*Hemiptera*)	1.4	Stink Bugs	11.1
Total Droppings	3,998	Total Droppings	251

Beechbuds were consumed in large quantities during those periods when deep snow lay on the ground. Most of the budding occurred when the birds were feeding on the ground on seedlings from three to six feet high rather than on the larger trees. It is doubtful if much food value was obtained from the beechbuds as they were in the winter condition and when found in the droppings they resembled frass. This differed from droppings of ruffed grouse which digested most of the buds eaten.

Ferns were identified first from droppings collected in October but they did not become abundant in the diet until January when they were second in frequency. One flock from Kennison Mountain was found to have been feeding on ferns about 90 per cent of the time in January, even when snow did not cover the ground. From signs and feeding observations, it was determined that most of the fern was consumed when the turkeys were feeding along the streams and at the bottoms of rocky ledges. The appearance of fern so often in the diet during periods of food scarcity seemed to indicate that it may have been a stuffing food rather than one which was preferred.

Hemlock leaves were found in large quantities from localized areas during

February and March. The tough, fibrous needles were not broken up thoroughly in the gizzard but were passed almost entire in some cases. It was estimated that little more than one or two per cent of the needles were of food value. Hemlock needles were found in the crops and gizzards of four birds that had starved to death. A series of droppings collected from a bird which later died from starvation indicated that it had been feeding extensively on hemlock needles for some time.

Bryophytes were a common food item from January to April in the beech-birch-maple-hemlock forest. It was possible that this was a local feeding habit under conditions of food scarcity, for Good and Webb (1940) in Alabama grouped the moses, ferns, and fungi together and reported that they formed only .46 per cent of the total volume. It was found in one winter dropping by Kozicky (1942) in Pennsylvania and May, Martin, and Clarke (1939) did not report it as a winter food of the turkey on the George Washington National Forest. Most of the bryophytes were identified as *Lycopodium* but others occurred which could not be identified. Luxuriant growths of bryophytes, which were available as food even during periods of heavy snows, were found along the protected stream banks and rocky ledges.

Wild grapes were a preferred food in the oak-hickory-pine forest. Grape vines were present in the beech forest but few of them ever produced enough fruit to be of value. The fleshy fruits were attractive to the turkeys for they would travel long distances to feed in the grape thickets. Some of the grapes were persistent and provided an excellent source of winter food. Grapes were most important as a food item during February.

Dogwood was consistently taken throughout the turkey range and especially during the early winter. The 1946 crop of *Cornus florida* and *C. amomum* was unusually heavy and was utilized to a correspondingly large extent. The fruit of the dogwood appeared in 180 of 251 droppings from the oak-hickory-pine range, yet in the beech association it was identified from only 679 of 3,998 droppings. Turkey scratchings were so common under dogwood trees that the observers often were able to locate and identify the trees at a distance by the accompanying sign. The food value of the fruit was probably limited to the fleshy, outside pulp, but the hard seed coats appeared to be retained in the gizzard and possibly functioned as grit.

Blackberry was prominent in the September foods and occurred more often in droppings collected from the beech woods. Small quantities were consumed all fall but not until January and February did it rise again to importance. Dried blackberries remained on some of the canes until early spring and it was these dried fruits that entered into the picture when the snow limited the availability of other foods. The seeds were pulverized in about 10 per cent of the cases by the action of the gizzard and quite often the small interior nutlets were not utilized.

Seed coat remains of wild cherry (*Prunus serotina* and *P. pennsylvanica*) indicated that it was a food item of greatest dietary importance during the late summer and early fall. Very high

representations were noted in all seasons in certain areas where wild cherry was available. The fruit was not persistent in that it remained hanging on the tree but it did provide a ready source of nutritional food when the birds could scratch under the trees. Kozicky (1942) stated that wild cherry was taken during all four seasons of the year in Pennsylvania, ranking fifth in importance. Except for the hard seed coat, the fruit of wild cherry was utilized entirely.

ANIMAL FOOD

Only beetles and stink bugs occurred consistently in the droppings. Other animal matter of less importance were millipeds, grasshoppers, and spiders. The percentage of insects found in the diet might have been greater had a more representative sample been taken during the summer months. Those insects that were eaten probably had been uncovered from their places of hibernation in the leaves and forest debris.

MISCELLANEOUS FOOD ITEMS

The seeds of wild raisin, wild indigo, greenbrier, hawthorn, smartweed, and witch hazel occasionally provided food but were of minor importance. Such animal matter as ants, insect eggs, and cocoons were also sampled but contributed little to the total food consumed.

GRIT

It is generally known that grit plays an important part in the digestion of the food eaten by turkeys. The amount of grit required or present in the gizzard or crop at any one time is dependent upon the recent food habits of the individual. Hard seeds such as dogwood, wild cherry, greenbrier, blackberry, and wild grape evidently are retained at will to supplement the grit or gravel ordinarily picked up. The grinding action of the wild turkey gizzard is very strong and is capable of breaking the above seeds into fragments and grinding them up during the digestion process. The per cent of grit was not recorded for each dropping analyzed but notes were taken on the various amounts and it was found to vary from 0 to 70 per cent. About a tablespoon of grit and gravel was recovered from the crop and gizzard of each of the four birds which had died from starvation. No satisfactory explanation could be found for the fact that there was very little or no grit passed in the droppings composed of oats, corn, or grass; whereas, large quantities were found in those consisting of wild cherry, dogwood, and ferns. It might be that the hard materials such as seeds and grit were passed at the same time because they were similar in composition and fundamentally served the same purpose.

DISCUSSION

The wild turkey is a nomadic feeder and has a tendency to sample a wide variety of foods. The amounts, kinds, and types consumed basically depend upon the availability. The fruit of the wild cherry was not consumed in large quantities until it ripened and fell. In Hampshire County the turkeys were walking under and passing up grape vines loaded with fruit because the vines were growing on the tops of trees 40 to 60 feet high. After a severe wind storm, which blew most of the clumps of grapes from the vines, the turkeys fed extensively on the dried fruit and

remained in the vicinity until it was consumed. Thus the degree of access materially affected the proportions of food consumed.

The preferences shown for certain food items are affected by several factors. Palatability seems to be one of the more important. Whether the birds actually are able to "taste" their food is not known but it is evident that they show a positive reaction to certain food items and to others their interest is only passing or often is negative. It may be said that palatability can be divided into two parts: (1) edibility, which is how the bird likes it, and (2) nutritionality, which is how the food physiologically benefits the consumer. Edibility usually includes all of the items eaten from those which are preferred to the emergency and stuffing foods. Blackberry, wild grape, beechnuts, wild cherry, and dogwood rate high in the food scale of the wild turkey. On the other hand hemlock needles, ferns, bryophytes, and lichens seem to be taken more as a last resort. The high fat and protein content of beechnuts placed them well up on the nutritional scale. Wild grapes and dogwood also rate high nutritionally because they are a good source of carbohydrates, but the value of such items as greenbrier, cancer-root, witch hazel and winter beech buds is questionable.

Stoddard (1941) pointed out that game birds might have to learn to eat certain foods by experience. This was clearly shown to us in Cranberry Game Refuge by the turkeys which walked over emergency feed of corn and oats and did not eat any, even though they were in a starved condition. They had never become acquainted with these artificial foods and hence passed them up. By the addition of raisins, a natural appearing food, we were able to get the turkeys to start feeding in the area and soon they sampled the corn and oats which thereafter they recognized as food.

Certain errors occur in dropping analyses as a result of palatability: (1) those foods which are eaten and utilized to a great extent do not show up in corresponding large amounts, for example, beechnuts, wild grape, *Viburnum*, and hawthorn; (2) certain items appear in large quantities in the feces which are of questionable food value, such as greenbrier and bryophytes; and (3) small, hard seeds which do not break up readily and may be of little food value but to serve some function such as grit or roughage are found abundantly in some droppings, such as the seeds of vetch or foxtail and the leaves of grasses and sedges.

MANAGEMENT

Several management procedures can be suggested as a result of this analysis, most of them concerned with habitat improvement and applicable to a large protion of the wild turkey range in the Northeast.

Stream improvement such as low log dams would create shallow pools and increase the winter feeding area along the banks. Dams of this type in Kumbrabow State Forest have materially augmented the general winter feeding territory. Permanent springs can be cleaned out and improved. The area that the water flows or seeps over will remain comparatively free from snow during most of the winter.

The harvest from natural food plants

such as dogwood, wild cherry, wild grape, greenbrier, beech, and oak, which are growing under suppressed conditions, can be increased by felling trees and cutting brush to free the food producers. Those trees with wild grape vines growing high in their branches should be felled and the vines trimmed to make them produce a larger and more available crop. Greenbrier can be encouraged by cuttings along forest trails and around the edges of openings.

The food supply may be increased by opening up old trails and logging roads which have become shaded to the point where they produce little. Blackberry, wild raisin, strawberry, vetch, and wild indigo will soon become established in these open places to provide a wide variety of food. This practice was already in effect on Beaverdam Game Refuge where it was producing excellent results by holding the turkeys on the refuge throughout a large part of the year.

If artificial food plots are contemplated, it would be well for the game manager to place them on the warm, protected slopes which are more likely to be frequented during inclement weather. In the past it has been found that game food plots may not live up to expectations largely because they do not stand up under severe winter storms. Artificial feeding is not recommended as a general procedure but rather as an emergency practice during times when snow covers the ground for extended periods. In most cases wild turkeys will get along very well if left to their own resources and sometimes artificial feeding can lead to embarrassing or costly results.

SUMMARY

1. The data presented were obtained from an analysis of 4,299 wild turkey droppings collected, for the most part, during the winter months. Of these 4,048 were from turkey range in beech-birch-maple-hemlock forest and 251 from oak-hickory-pine.

2. A comparison of analysis methods indicated that the dry method of examining each individual dropping gave the most satisfactory results.

3. Vegetable matter made up 98.32 per cent and animal matter 1.6 per cent of the total volume.

4. The emergency artificial feed of oats and corn were the most abundant food items identified.

5. The ten natural foods which were of importance in the diet in descending order were grasses, beechnuts, beechbuds, ferns, hemlock leaves, bryophytes, wild grape, dogwood, blackberry, and wild cherry.

6. Preferred foods were beechnuts, wild grape, blackberry, wild cherry, and dogwood.

7. Emergency or stuffing foods apparently were beechbuds, ferns, hemlock leaves, bryophytes, lichens, and fungi.

8. Hard seeds apparently were retained in the gizzard for some time to serve as grit.

9. Much of the natural food produced each season does not benefit the wild turkey because it is not accessible.

10. Recommended practices to increase the natural foods are stream and spring improvement, freeing suppressed food plants, making more openings, and brushing out trails.

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VITAMIN A STORAGE IN WILD QUAIL AND ITS POSSIBLE SIGNIFICANCE[1]

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As a result of research on the vitamin A requirements of bobwhite quail conducted with pen-reared stock at Patuxent Research Refuge, Laurel, Maryland (Nestler, 1946), it was concluded that during winter especially, vitamin A apparently stands on a par with carbohydrates as a factor that could decide the fate of wild quail. It was shown that vitamin A deficiency might be a very important factor in population fluctuations of quail.

While carnivores can obtain their vitamin A from the tissues of other animals, quail, in winter at least, depend largely on carotene in plants. Unless they have stored away a plentiful supply in their livers, their chances for survival under adverse weather conditions are much reduced. Less carotene is manufactured in plants during a hot,

[1] Appreciation is expressed to Paul Errington, Robert Moorman, Don Thompson, the officials and observation officers of the Iowa Conservation Department, and the select group of Iowa sportsmen, whose unstinted cooperation made this investigation possible.

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dry period than during a cool, wet season. Combine a droughty summer and fall with a severe winter of prolonged snow, as was the case in Ohio during 1944–45 and Iowa during 1936–37, and the result seemingly is an ideal condition for vitamin A deficiency. Birds may die either directly or indirectly from avitaminosis. Weakness, impaired eyesight, lack of alertness, and loss of speed cause them to succumb to predation and severe weather. Thus, marginal intakes of vitamin A, while sufficient to keep birds from dying directly from avitaminosis, yet may undermine their constitutions to such an extent that death results from other causes.

Unfortunately we have very little direct evidence that vitamin A deficiency does occur among wild quail, or for that matter, among any other gamebirds. Cowan and Fowle, 1944, noted in one wild ruffed grouse, severe visceral gout, which is a positive symptom of vitamin A deficiency (See Nestler, 1945). However, "One swallow does not make a spring," neither does one case of visceral gout indicate that vitamin A deficiency is serious in the wild.

Under present methods of field research, true cases of acute A-avitaminosis among wild gamebirds may seldom or never be detected by the biologist, primarily because the majority of deficient cases probably become victims of predators while they are still only mildly affected.

The only other recourse at present is to check the storage of vitamin A in the livers of gamebirds, and then estimate the length of time the birds might have lived on that quantity of the factor, during a severe scarcity or absence of dietary vitamin A or carotene. There is no way at this time to determine whether or not the resulting deductions are correct. In order to sample the liver, one must sacrifice the bird. It has been suggested that a sample of liver from the living quail might be obtained by means of a "keyhole" operation or the use of a trocar. Such a solution is impractical. Even if the subject, especially one as small as a bobwhite quail, survived the operation, there is a good possibility that the shock of the trauma would modify the utilization of the vitamin A stores considerably so that results would not be reliable.

THE YARDSTICK

As a standard of comparison in the making of the estimate, figures are used that were obtained from studies (Nestler, 1946) on the vitamin A requirements of pen-reared bobwhites during the winter-maintenance period. It was found that in the case of an otherwise well-balanced maintenance diet, one thousand units of vitamin A per pound of feed gave optimum livability during the winter, but was insufficient for subsequent egg production. Optimum production occurred among birds that had received 2,500 or more units of vitamin A. Apparently the reason for this effect on production is that no appreciable quantity of vitamin A was stored until the level of the vitamin in the diet reached 2,500 I. U. per pound. This fact indicates that despite appearances, the body's requirements for maintenance were not met by 1,000 I. U. per pound of feed.

Placing the requirements on a daily basis, the quail require at least 40 I. U. of vitamin A per day for survival during winter, and 100 I. U. for maximum body needs and optimum subsequent

reproduction. Actually there is considerable variation between birds as to vitamin requirement and utilization, even between quail from the same hatch and of the same parentage. The figures of 40 and 100 I. U. daily for maintenance are, of course, based on the requirements of the average bird.

A total quantity of vitamin A in the liver of quail divided by 40, is considered as giving the number of days the birds might survive, barring all predation and severe weather, after being forced to subsist on a diet nearly devoid of vitamin A or carotene. The total quantity of stored vitamin A divided by 100, is considered as giving the number of days the birds would live on a deficient diet before manifesting some slight symptoms of deficiency, such as, impaired eyesight, decreased alertness, etc., conditions that would encourage predation and loss by severe weather.

PRELIMINARY STUDIES

Field studies were conducted during the winters of 1945–46 and 1946–47 in order to determine if information could be obtained from the livers of birds to furnish a clew to the solution of this problem. In the work of both seasons, birds were obtained primarily from four states, Pennsylvania, Maryland, Virginia and Alabama. In the second year, a few specimens were also received from Florida and South Carolina.

These preliminary studies showed no correlation between the weight of quail and the weight of liver, and none between the weight of liver and the quantity of vitamin A stored. There was a positive correlation between the size of liver and the section of the country, the livers being largest in birds from Pennsylvania, and becoming progressively smaller with the more southern samples. However, the small number of the specimens involved during both years (52 birds for 1945–46 and 16 for 1946–47) prevents the results from being statistically significant.

Forty-six per cent of the 52 birds obtained in 1945–46 showed less than 210 I. U. of vitamin A per gram of liver (840 I. U. of total vitamin A in their livers) which could mean that they did not have sufficient quantity to help them through three weeks of scarcity. The range in quantity stored was from 20 I. U. to 1,360 I. U. per gram of liver (46 I. U. to 4,350 I. U. total vitamin A).

The 16 birds of 1946–47 showed much higher storage of vitamin A than the birds of the previous winter, the range of storage being from 437 I. U. to 2,000 I. U. of the vitamin per gram of livers (1,050 I. U. to 7,000 I. U. total vitamin A). Sixty-two per cent had over 2,500 I. U. of total vitamin A, or more than enough to tide them over nine weeks of scarcity in the diet. Only one had insufficient vitamin A to help it survive four weeks of dietary deficiency.

This difference introduces the possibility that storage may vary considerably from year to year depending on factors affecting the synthesis of carotene in plants, the severity of the winter, and even the food habits of the birds themselves. Inasmuch as extreme weather conditions should promote vitamin A deficiency, it seemed desirable to conduct an intensive field investigation in a portion of the quail range where such conditions might exist.

THE MIDWESTERN INVESTIGATION

During the spring of 1947 the center of Iowa's quail range was subjected to severe floods that destroyed the early quail nests and drove the breeders to

high ground. Following the floods came a severe drought that persisted through the summer to the last of September. As a consequence late planted corn and other crops were only poor to fair in quality.

Many of Iowa's 1947 quail were late-hatched which meant that they had less vitamin A supplied to them by the hen than early hatched birds would have had. Then too the parent's food supply had been affected by the drought at the time of the later hatch. Also the chicks were raised on drought-affected foods and had to subsist on such during the winter. Drought-affected plants are lower in carotene than plants grown under normal weather conditions. If in the light of these adverse conditions the quail also had to face heavy prolonged snow and ice blanketing their range throughout the winter, then A-avitaminosis might be in evidence. A similar situation during 1936–37 in southern Iowa caused an estimated quail loss of 88 per cent.

With a severe winter in prospect, the senior author established temporary headquarters in southern Iowa during the late fall of 1947 and enlisted the services of the Iowa State Game Commission, sportsmen, and fellow scientists to collect specimens during the hunting season in order to determine the condition of the birds as they were entering into the winter. At the close of the hunting season arrangements were made with conservation officers, farmers, and sportsmen for the collection of weak or dead quail that might be found during or subsequent to a heavy prolonged coverage of snow or ice.

Unfortunately for the investigation, the weather in the Midwest was not as severe as anticipated. The quail range of Iowa had only two heavy snows, one early in January and another in March, but neither lasted long enough in rural areas to create a critical food situation. On the whole the weather in Iowa and even Wisconsin, where a few specimens were collected, was very open during this winter. Consequently, no weak or dead birds were found. In fact, all coveys except one in northern Wisconsin, appeared to be in good condition.

In addition to 395 specimens collected from thirty-five counties in Iowa and one in Illinois during the hunting season, fifty more were obtained throughout the winter from nine Iowa counties, and three Wisconsin counties.

Livers from the birds were removed; placed in tightly closed bottles; labelled as to age and sex of bird, and county and date of kill; quick-frozen; held in a deep freeze; and shipped by express in dry ice to the chemical laboratory at Patuxent Research Refuge, Laurel, Maryland, for assay. Four and eight-tenths per cent of the livers weighed less than two grams (some weighed only 0.5 gram for adult birds); 50.8 per cent, between two and four grams; 39.4 per cent between four and six grams; 4.2 per cent, between six and eight grams; and 0.7 per cent, over eight grams. The average weight was four grams.

RESULTS

The data are summarized in Table 1. The grouping into sections is somewhat arbitrary for the sake of simplicity. The figures representing "the percentage of birds that could die directly from A-avitaminosis" are based on the aforementioned standard of comparison developed from pen-reared stock, namely,

TABLE 1.—STORAGE OF VITAMIN A IN LIVERS OF BOBWHITE QUAIL FROM 39 COUNTIES AND THREE MIDWESTERN STATES, AND THE POSSIBLE SIGNIFICANCE

State	Section	Counties	No. of Cases	I.U. Vitamin A Stored per gram Liver		Percentage of birds that could die directly from A-avitaminosis within the time specified*			
				Ave.	Range	12 wks.	9 wks.	6 wks.	3 wks.
Iowa	Central	Story, Polk, Madison, Warren, Marion	36	620	189–1199	72	58	36	3
	East Central	Benton, Linn, Iowa, Johnson, Mahaska, Keokuk, Washington	91	521	121–1154	91	69	27	2
	South West	Union, Clarke Taylor, Ringgold, Decatur	34	549	89–1844	85	65	47	9
	South Central	Lucas, Monroe, Wayne, Appanoose	91	706	205–2844	71	53	21	1
	South East	Wapelle, Jefferson, Davis Van Buren	84	708	122–1625	74	36	12	5
	Lower Mississippi Valley	Louisa, Henry, Des Moines, Lee	57	678	180–2240	76	45	24	2
	Middle Mississippi Valley	Jackson, Clinton, Scott, Cedar, Muscatine	26	654	158–1876	69	62	31	8
	Upper Mississippi Valley	Allamakee	2	520	290– 750	100	50	50	None
Illinois	Upper Mississippi Valley	Henderson	6	393	162– 524	100	100	50	17
Wisconsin	Northern	Dunn	3	655	282–1004	67	33	33	None
	Southern	Sauk, Columbia	18	350	50– 780	100	89	67	22

* It is emphasized that these figures are theoretical; that they are based upon observations on pen-reared birds; that no control studies were conducted to determine survival time for other quail from these coveys, and that conditions resulting in the complete removal of dietary sources of vitamin A might never be encountered in natural habitats.

40 I. U. of vitamin A daily, the quantity necessary for optimum survival barring predation or very severe weather. If the figure of 100 I. U. daily, the quantity required for maximum body requirements, had been used instead of 40 I. U. then the percentage of birds that might have died indirectly from vitamin A deficiency through lack of optimum alertness, speed, vision, and stamina, would have been much higher for each period of time considered. This point is demonstrated in Table 2. Thus 42 per cent of all the birds tested could have

TABLE 2.—POSSIBLE QUAIL MORTALITY AMONG 445 BIRDS CAUSED DIRECTLY AND INDIRECTLY BY VITAMIN A DEFICIENCY

	Period of Time*			
	12 wks.	9 wks.	6 wks.	3 wks.
Percentage dying directly from deficiency	77	56	27	4
Percentage dying indirectly from deficiency through predation and severe weather	100	99	87	42

* It is emphasized that these figures are theoretical; that they are based upon observations on pen-reared birds; that no control studies were conducted to determine survival time for other quail from these coveys, and that conditions resulting in the complete removal of dietary sources of vitamin A might never be encountered in natural habitats.

died indirectly from vitamin A deficiency in less than three weeks of scarcity, and 87 per cent in less than six weeks.

There was no significant difference in the quantity of vitamin A stored by young birds and by adults, or that stored by cocks and by hens. The average quantity stored per gram of liver by each of the groups was as follows: Young cocks, 633 I. U.; young hens, 635 I. U.; adult cocks, 596 I. U.; adult hens, 681 I. U. In general the stores of vitamin A in birds taken in January and February were lower than those of the hunting season. This situation is as one might suspect. However, the small number of samples of the former taken from any one county prevents statistical significance.

DISCUSSION

Although the results from this investigation make good material for demonstrating the possibilities of nutritional deficiency in the wild, they do not prove that such a deficiency actually ever exists. Even the occurrence of several cases of acute visceral gout, would not establish the fact that A-avitaminosis is a serious factor under natural conditions. Unless large numbers of wild quail can be found manifesting the deficiency, proof will still be lacking. And, as has been pointed out before, the predators and scavengers would probably obtain the specimens before the biologists could.

In order to find a satisfactory answer to this problem, as well as to many others that plague the game manager, it is suggested that islands be obtained for controlled field studies. If arable islands are of the proper size for close observations on the game at all times without confining the subjects too closely, and far enough from other land to prevent ingress and egress of either the game or mammalian predators, they should provide the means to solving such problems.

In the meantime, in addition to abundant cover and food high in easily digestible carbohydrates to supply heat and energy to birds, it is recommended that highly pigmented foods be supplied as sources of carotene. Multiflora and wild rose hips, sumac and bittersweet fruits, smartweed seeds and acorns are wild foods known to be good sources of provitamin A (See Nestler, Derby, DeWitt, 1948). Some of these, however, such as sumac fruits, when used as the main source of food, will not support quail very long. There must be a source of easily digestible carbohydrates. Yellow corn, fortunately, is one food that combines both desirable features. In the northern part of the quail range, food must be provided that will be accessible to quail in times of prolonged deep snow. This point is very important to bear in mind when planning environmental improvements for quail.

SUMMARY

The livers of 445 wild bobwhite quail from thirty-five Iowa counties, three Wisconsin counties and one Illinois county, were obtained during the late fall and winter of 1947–48 and assayed for vitamin A. None of the birds examined showed any internal signs of A-avitaminosis, and all the livers showed some vitamin A storage from a low level of 50 I. U. per gram to a high 2,844 I. U. per gram. It is estimated on the basis of results obtained on pen-reared quail,

that four per cent of the wild birds would have died directly from A-avitaminosis within three weeks after a scarcity developed in the diet, or 42 per cent could have died indirectly from the deficiency within the same length of time, through predation and severe weather.

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VITAMIN A AND CAROTENE CONTENT OF SOME WILDLIFE FOODS

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In nutrition investigations with bobwhite quail at the Patuxent Research Refuge (Nestler, 1946) it was found that, during the winter especially, vitamin A stands on a par with carbohydrates as a factor deciding the fate of quail. While carnivores can obtain their vitamin A from the tissues of other animals, quail, in winter at least, must depend largely on the carotene of plants. Unless the birds have stored a plentiful supply of the vitamin in their livers, their chances for survival are slim during periods of prolonged deep snow. Storage by quail of vitamin A from carotene is much less than that from an equivalent quantity of true vitamin A (Nestler, Derby, and DeWitt, 1948). All but about 15 per cent of an adult quail's diet is vegetable matter; the rest consists of insects and other invertebrates. Unless invertebrates convert carotene to vitamin A as do mammals, birds, and others, the quail must depend entirely on provitamin A.

Bowers and McCay (1940) demonstrated that the cockroach (*Blattella germanica*) needs neither vitamin A nor carotene in the diet, and is able to function normally throughout life without this vitamin. Therefore, Rosenberg (1945) suspects that some other invertebrates may not require vitamin A. Nevertheless, as indicated by the studies of Palmer and Knight (1924) on the stink-bug (*Perillus bioculatus*) and other species, the red and yellow colors in the hypodermis of insects may be due to some extent, if not largely, to carotinoid pigments derived from the food.

Very little work has been published on the carotene content of wild plants. King and Titus (1943) ran experiments with ground acorns of willow oak (*Quercus phellos*) in the diets of domestic chicks. They concluded that vitamin A activity of the acorns was of the order of 180 I.U. per gram or roughly 80,000 I.U. per pound (about 40 times the potency of yellow corn).

In order to determine the possible sources of vitamin A for quail, 37 species of insects and other invertebrates were analyzed spectrophotometrically for vitamin A by a modification of the technique of Wilkie and DeWitt (1945), and for carotene by the method of Wall and Kelley (1943), the entire body being used in all cases. Likewise, 26 species of seeds and fruits partaken by quail, were assayed for carotene.

VITAMIN A AND CAROTENE CONTENT OF INSECTS & SOME OTHER INVERTEBRATES

The invertebrates tested included the following: *Diabrotica duodecimpunctata* (spotted cucumber beetle), *Leptinotarsa decimlineata* larvae and adults (Colorado potato beetle), *Epilachna varivestis* (Mexican bean beetle), *Popillia japonica* (Japanese beetle), *Phyllophaga* sp. (May beetle or June bug), Coccinellidae (ladybird beetle or ladybug), Scarabaeidae (scarab beetles), Scoliidae (Scoliid wasps), Cercopidae, nymphs and adults (spittle bugs), Miridae (plant bugs) Corimelaenidae (negro bugs), Pentatomidae (stink bugs), *Anasa tristis* (squash bug), Lampyridae (lightning bugs), Mantidae (praying mantis), Acrididae (grasshoppers), Tettigoniidae (katydid), *Gryllus assimilis* (cricket), Anisoptera (dragon flies), Zygoptera (damsel flies), Tabanidae (horse flies), Vespidae (wasps), Halictidae (sweat bees), Bombidae (bumble bees), *Tenebrio* sp. larvae (mealworms), Buprestidae (metallic wood borers), *Formica fusca*, adults and cocoons (black ants), Lumbricidae (earthworms), *Pieris rapae* (cabbage butterfly), Circtiidae larvae (tiger moth), Heterocera (small moths), *Malacosoma americana* (American tent caterpillar), *Ceratomia catalpae* (Catalpa caterpillar), *Sceliphron* sp. (mud daubers), Geometridae (measuring-worms), *Latrodectus mactans* (black widow spider), and Araneida (miscellaneous spiders).

TABLE 1.—BETA-CAROTENE CONTENT OF SOME COMMON INSECTS

Name of Insect	Carotene (I.U. per gram)
Leptinotarsa decemlineata (Colorado potato beetle)	
larvae	233
adults	184
Epilachna varivestis (Mexican bean beetles)	201
Acrididae (grasshoppers)	60
Diabrotica duodecimpunctata (spotted cucumber beetles)	48
Mantidae (praying mantis)	20
Malocosoma americana (tent caterpillar)	13
Ceratomia catalpae (catalpa caterpillar)	5
Popillia japonica (Japanese beetles)	4

Only four of the thirty-seven gave any reading for true vitamin A, namely Lumbricidae (earthworms), *Tenebrio* larvae (mealworms), Cercopidae nymphs (spittle bugs), and Araneida (spiders). Nevertheless, additional assays on these four failed to confirm the results of the first analysis, and showed no trace of vitamin A.

Carotene was found in eight herbivorous invertebrates and one carnivorous insect, the praying mantis, in some cases the concentration being very high. The results are given in Table 1. If quail make such insects as the Colorado potato beetle about 15 per cent of their diet, they would receive more than five times the quantity of provitamin A necessary for optimum reproduction,

namely, 6,000 I.U. per pound of feed (Nestler, 1946).

CAROTENE CONTENT OF PLANTS

The carotene content of some foods of plant origin is shown in Table 2. Among the foods showing a high concentration of the factor are the seeds (achenes) of smartweed, certain lespedezas, Wilson black soybeans, and mung beans; as well as fruits of sumac, multiflora rose, wild rose, bittersweet, wahoo or burning bush, bitter nightshade, and indigobush.

TABLE 2.—BETA-CAROTENE CONTENT OF CERTAIN SEEDS AND FRUITS USED BY QUAIL IN THE WILD

Name of Plant Seeds	Carotene (I.U. per gram)	Name of Plant Fruits	Carotene (I.U. per gram)
Chamaecrista fasciculata (showy partridgepea)	4.0	*Phaseolus aureus* (Oriental mung bean)	13.7–19.5
Bidens aristosa (bearded beggartick)	0.0	(Domestic mung bean)	14.1–29.9
Rumex, sp. (dock)	0.0	*Sypmhoricarpos orbiculatis* (buckbrush, coralberry)	0.0
Polygonum punctatum (dotted smartweed)	24.6	*Amorpha fruticosa* (indigobush)	8.2
Polygonum pennsylvanicum (Pennsylvania smartweed)	2.8–4.6	*Celastrus* sp. (bittersweet)	18.3–20.4
Ambrosia artemisiifolia (common ragweed)	0.8–6.9	*Vitis labrusca* (fox grape)	1.6
Lespedeza bicolor (shrub lespedeza)	1.5	*Evonymous atrapurpureus* (wahoo)	11.8
Lespedeza formosa (Formosan lespedeza)	12.5	*Solanum dulcamara* (bitter nightshade)	9.3
Lespedeza daurica (Daurica lespedeza)	20.3	*Rosa* sp. (wild rose)	2.6–14.5
Lespedeza stipulacea (Korean lespedeza)	2.6–6.7	*Rosa multiflora* (multiflora rose)	4.2–20.0
Lespedeza sericea (Chinese lespedeza)	0.5	*Rhus copallina* (dwarf sumac)	3.5–23.5
Glycine max (Wilson Black soybean)	0.9–17.1	*Rhus glabra* (smooth sumac)	1.4–14.6
		Rhus typhina (staghorn sumac)	1.8–7.9

Apparently considerable variation can exist in the carotene-content of plants of the same species and even among fruits on the same plant at the same time. In tests conducted on the fruits of smooth sumac (*Rhus glabra*), samples taken from three lots of the shrub at widely separated points on the Patuxent Research Refuge during November, assayed 26, 12, and 6 I.U. of carotene per gram respectively; three other clusters of fruits from the same plant contained 2, 3, and 12 units per gram respectively; and an old cluster (of previous year) together with a fresh cluster, both from the same bush, assayed 3 and 11 units per gram respectively. An analysis of sumac fruits collected from the field eight times throughout the year revealed no correlation between their carotene-content and the season. The average results were as follows: January, 5 I.U. per gram; March, 8 I.U.; May, 1 I.U. July, 7 I.U.; August, 8 I.U.; September, 5 I.U.; October, 3 I.U.; and No-

vember, 15 I.U. Similar tests with dwarf sumac (*Rhus copallina*) revealed the same type of variations.

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OHIO PHEASANT NESTING SURVEYS BASED ON FARMER INTERVIEWS

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Since its establishment in 1936 the Ohio Cooperative Wildlife Research Unit has been conducting various studies on the State's most popular game

[1] The Ohio Division of Conservation and Natural Resources, the Ohio State University, the U. S. Fish and Wildlife Service and the Wildlife Management Institute cooperating.

This report is based largely upon progress reports summarizing annual pheasant nesting and roadside census surveys and prepared as mimeographed releases by the Ohio Wildlife Research Unit for its cooperators. These reports include releases 116, 119, 122, 124, 145 and 152 by Dr. Lawrence E. Hicks who was in charge of the earlier surveys; releases 82, 123, 125, 153, 187, 188, 189, 192 and 193 by the author; release 170 by Lawrence E. Hicks, Daniel L. Leedy and Don H. Strode; release 135 by Don H. Strode and Daniel L. Leedy; release 157 by Don H. Strode and a progress report by Dr. Charles A. Dambach covering the 1945 roadside census. The assistance of numerous students in conducting these surveys is gratefully acknowledged as is also the cooperation of the thousands of farmers who were interviewed. Charles A. Dambach, George A. Petrides and Eugene H. Dustman of the Ohio State University; Irven O. Buss of the Wisconsin Conservation Department; and Harlow B. Mills of the Illinois Natural History Survey made valuable suggestions in the preparation of this report.

[2] Since submitting this paper Dr. Leedy has transferred to U. S. Fish and Wildlife Service, Washington, D. C.

bird, the Ring-necked Pheasant (*Phasianus colchichus torquatus*). One of the techniques evolved as a means of obtaining information regarding pheasant population trends, life history and pheasant-land use relationships, is based on personal interviews with farmers. In this type of survey it is recognized that a vast majority of the pheasants are produced on privately owned farm land and that the farmer has an opportunity to observe, at first hand, the pheasants living on his farm. The farmer is thus in a position to furnish much valuable information on the pheasant and other wildlife, the accuracy of the information depending to a considerable extent on his ability as an observer, his interest in wildlife and the manner in which he is approached, i.e., the ability of the interviewer seeking the information

This paper describes the farmer-interview method of making extensive pheasant nesting surveys in Ohio and summarizes some of the information obtained as a result of surveys conducted from 1937 to 1947.

The annual surveys were conducted in from two to thirty-one counties. The portion of this report dealing with pheasant population trends and distribution is based on data from only two counties, Henry and Wood, in which nesting surveys were conducted from 1937 to 1940 inclusive and in 1946 and 1947. Information from these and from other counties in which surveys were not made in consecutive years, is used in the sections on nesting densities according to cover types, mortality and other phases of the study.

METHOD

The method is based upon personal interviews with farmers who have mowed hay or grain crops and who report upon the number of pheasant nests found in each field mowed. A record is kept on mimeographed forms of the kind of crop, manner and date of harvesting, number of nests seen, whether hatched or unhatched at the date of cutting and the number of pheasants killed or crippled in the harvest operations (Figure 1). The nesting densities are later calculated on the basis of the number of pheasant nests per 100 acres of cover. Casualty rates due to harvesting activities are tabulated according to the number of pheasants killed and/or crippled per 100 nests uncovered in mowing.

Additional information, including data on the percentage of farmers who hunt, the average kill of game per farmer-hunter, farmer attitudes toward pheasants and current hunting regulations or other management measures, relative abundance and distribution of various game species, land use practices affecting pheasant production and other factors, is also obtained by the interviewers.

The survey is usually made during the latter half of June and the month of July. From 15 to 20 farm operators, well distributed in each township and representing about 7 per cent of the total farms, are interviewed. Under conditions existing in the Ohio pheasant belt an average of about 20 farmer-interviews can be made daily in driving approximately 60 miles. Interviewers who have lived on a farm or have knowledge of farm conditions and can speak the farmers' language are probably able to gain the farmers' confidence and obtain more reliable information than others. Experience has shown that most farmers have considerable interest in wildlife

FIG. 1.—Sample Survey Form.*

OHIO WILDLIFE RESEARCH UNIT — OHIO STATE UNIVERSITY, COLUMBUS, OHIO

INTERVIEW FORM FOR PHEASANT NESTING STUDY AND GAME SURVEY

County: Wood — Township: Liberty
Date: 8 July 1947 (Day-month-year) — Interview no. for twp. 7

Pheasant nesting density and mortality:

	Field No. 1	Field No. 2	Field No. 3
A. Alfalfa:			
Date mowed	June 20		
Size of field	8		
No. of nests seen	3		
No. of nests hatched	1		
No. of hens killed	1		
No. of hens crippled	0		
No. other killed	0		
No. other pheasants crippled	0		
B. Other Hay	Red Clover	Timothy	
Date mowed	June 26	June 30	
Size of field	10	6	
No. of nests seen	3	2	
No. of nests hatched	2	1	
No. of hens killed	0	0	
No. of hens crippled	1	0	
No. other pheasants: killed	0	0	
No. other pheasants: crippled	0	0	
C. Wheat			
Date cut: combine or binder	July 5		
Size of field	12		
No. of nests seen	2		
No. of nests hatched	2		
No. of hens killed	0		
No. of hens crippled	0		
No. other pheasants: killed	0		
No. other pheasants: crippled	0		

How long since farmer has seen bobwhites on his farm 6 months
How long since farmer has seen Hungarian partridges on his farm 4 years
Did farmer hunt last year? yes No. pheasants 4, No. rabbits 6
No. Hungarian partridges 0; fox squirrels 3
Did any members of farm family night hunt or trap last season yes
No. raccoons 3; skunks ; opossum 6
No. muskrats 17; weasels ; foxes
Did farmer ship his fur out-of-state or sell to Ohio dealer: Ohio dealer

NAME OF INTERVIEWER John Doe

*Reduced from 8½ x 11 inch size.

FIG. 2.—Sample Survey Form.*

OHIO WILDLIFE RESEARCH UNIT OHIO STATE UNIVERSITY, COLUMBUS, OHIO

DAILY REPORT - PHEASANT SURVEY

1. Name of observer John Doe
2. Date July 8, 1947
3. County Wood
4. No. of miles driven 60
5. No. of miles walked 2
6. No. of farmers interviewed 20
7. No. of pheasants seen: adult hens 8 ; adult cocks 3 , young 25
8. No. of hen pheasants with young 3 ; without young 5
9. No. of juvenile males ; juvenile females ; sex unknown 25
10. No. of bobwhites seen 2 ; No. heard only 3
11. No. of male bobwhites 1 ; female 1 , sex unknown
12. No. of young bobwhites seen , No. of broods
13. No. of Hungarian partridges seen ; No. of flocks
14. No. of mourning doves seen 12 ; crows 19
15. No. and kind of hawks seen 2 marsh; 1 red-tailed
16. Live rabbits 1 ; live squirrels 2 other mammals
17. Highway mortality:

    Pheasants: adult cocks ; adult hens 1
    juvenile cocks , juvenile hens ;
    sex unknown

    Bobwhites: males ; females ; young

    Hungarian partridges: males ; females ; young

    Rabbits 3 ; fox squirrels 1 ; muskrats 1

    Skunks ; Opossum ; others

18. General observations: (food habits, predation, land use data, farmer attitudes towards increasing the supply of pheasants, etc.)

    Wheat fields: Cut 20 ; uncut 95

    Very few complaints about pheasant damage as compared with 1940. Foxes appear to be on the increase and Hungarian partridges remain at a low level. Heavy rains and floods are said to have destroyed many pheasant nests.

*Reduced from 8½ x 11 inch size

and after making some friendly introductory remark the interviewer can immediately begin his questioning. Often the most difficult task of the interviewer is to keep the conversation directed in such a way that he gets the answers to his questions rather than listening to expositions on politics or that much maligned predator, the fox. With experience, however, most interviews can be completed within a few minutes. The interviews are made as loads of hay are being brought into the barn, at the corners of fields or in other locations most convenient to the farmers.

In covering each township a county highway map is used for tracing the investigator's route and indicating the location of each interview by a number which corresponds to a number on the interview form. This permits a later consideration of any item of outstanding interest which might result from the interview. In driving to all quarters of each township the investigator has an excellent opportunity to take notes on land use factors, harvesting methods, highway mortality, sex ratio, abundance and distribution of pheasants and other wildlife observed, thus obtaining a summer roadside survey of game and habitat conditions while conducting the nesting survey. This information is recorded on a mimeographed form which ensures standardization and facilitates the compilation of final results (Figure 2).

Obviously the operator of a mowing machine, binder or combine cannot see all of the nests cut over during the harvesting operations nor can he be certain of the number of juvenile pheasant killed in mowing a field of hay. The number of hen pheasants killed or crippled in mowing can be determined with more accuracy. Provided that surveys are made in the same areas and under similar conditions year after year the method is useful in that it yields an index to relative pheasant populations.

It is advisable to carry on intensive pheasant nesting studies on sample areas in conjunction with the extensive surveys to determine the percentage of pheasant nests that are not reported by the farmers and to provide other checks. Thus, during the pre-war years, intensive studies showed that farmers reported approximately three-fourths of the nests actually present in hay and a smaller percentage of those in wheat or oats. In 1946 and 1947 Dustman (unpublished notes) found that a smaller percentage of the nests was being reported by farmers. He pointed out that the increased use of power and tractor-drawn mowers, which operate at much greater speeds than horse-drawn mowers, would probably result in a smaller percentage of the total nests being reported. He also concluded that heavy rains and flooding preceding the mowing would render nests relatively inconspicuous.

The number of pheasant nests reported per 100 acres of hay has been found to be a more accurate indicator of pheasant abundance than the nests in grain and is therefore used in our analysis of population trends. Although the number of pheasant nests per 100 acres of hay may be used as an index of relative abundance, it is necessary to establish a conversion factor if the number of pheasants are to be computed per 100 acres or per square mile. To do this requires accurate determination of the number of pheasants on sample areas

which are representative of the larger areas involved. A possible approach to the problem includes a combination of intensive pheasant nesting studies resulting in a knowledge of the percentage of pheasant nests occurring in hay as compared to other cover types, crowing cock and drive censuses on selected areas and analyses of records made on the sex and age ratios of pheasants observed, percentage of hens rearing young, size of broods and hunter kill tallies.

For game administrators and technicians who are in a position to adopt the farmer-interview game survey method, the following points may be worthy of consideration:

(1) It provides an index to the relative pheasant population early enough in the season that pheasant hunting regulations can be based upon the survey findings;

(2) It provides supplemental information on other species such as rabbits, bobwhites, Hungarian partridges, mourning doves and crows;

(3) It is a means of determining the extent to which farmers participated in the previous season's game kill;

(4) It provides valuable training for wildlife students and ensures a better understanding of the farmers' part in producing and harvesting the game crop;

(5) It provides a means of getting the farmers' points of view for game technicians and game protectors, presents an opportunity to get across some ideals of game management and lets the farmers know that game men are on the job;

(6) Because of the extensive coverage in each township, it ensures a first hand acquaintance with all parts of a county frequently bringing to light new problems in game management which require attention;

(7) It involves the hen, which is the significant potential breeder, rather than the cock, which is used in crowing count censusing. Studies of ovulation by Buss (1946) show that practically all hens, wild and artificially-propagated, lay eggs in good numbers. The hen is the important bird in determining fall shooting stock. Since the nesting survey method involves computations based on the hens it should be more representative than one based on cocks. Sex ratios would have to be known accurately in the case of the crowing cock census but not necessarily in the nesting survey method.

TRENDS INDICATED BY EXTENSIVE PHEASANT NESTING SURVEYS

Based on pheasant nesting densities in hay as reported by farmers the pheasant population of Henry and Wood Counties reached its height in 1940. No extensive nesting studies were made in 1941 at which time roadside surveys in six Ohio counties, including Henry and Wood, showed a peak population. Roadside surveys made in these two counties alone showed a slightly higher population in 1939 than in 1940 or 1941. In an intensive pheasant nesting study conducted on four square miles in Wood County by Don H. Strode (1942) and Eugene H. Dustman (unpublished notes) the greatest number of nests was found in 1941. A comparison of pheasant population trends indicated by various methods is shown for Henry and Wood Counties in Figure 3. Note that, on the basis of nesting

surveys, intensive studies indicated a pheasant population in 1947 only 30 per cent as great as the pre-war high, while the extensive method showed a population 32 per cent of that existing in 1940. Note also that fall roadside counts of pheasants in these two counties indicated a population in 1947, only 28 per cent as high as the 1939 population.

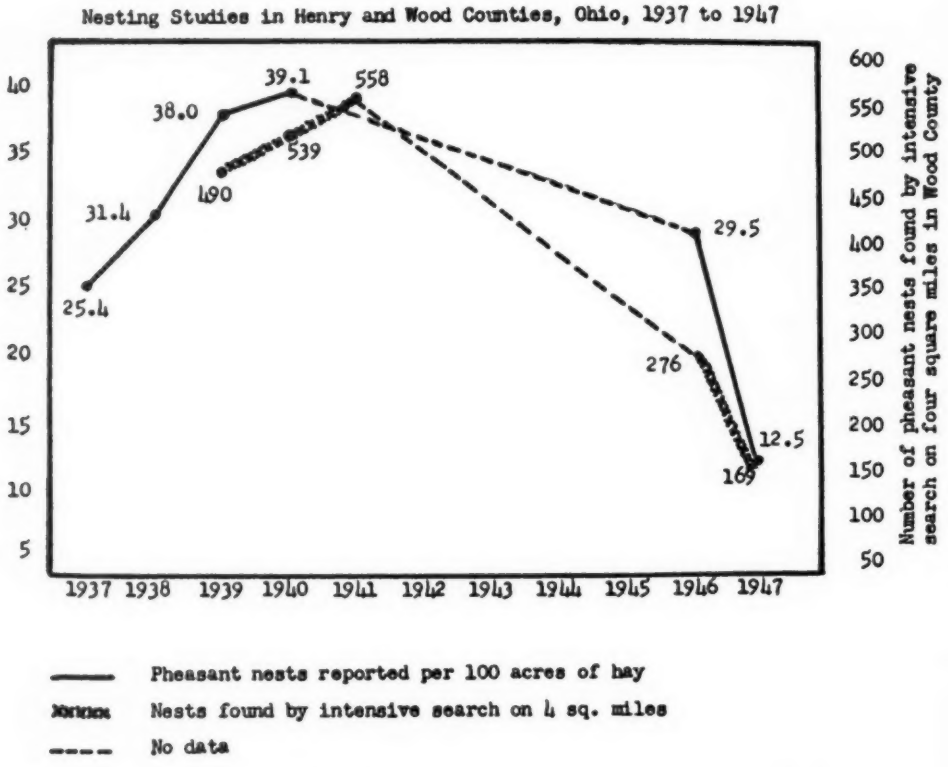

FIG. 3a.—Pheasant Population Trends as Determined by Average Number of Nests Reported per 100 Acres of Hay Meadow.

When the numbers of pheasant nests reported per 100 acres of hay are plotted according to townships on county outline maps a fair idea of pheasant distribution and relative abundance is obtained. Thus when such maps were prepared of Henry and Wood Counties a decrease in population levels was indicated in all of the townships except one. Decreases appeared to be least in townships serviced by refuges or in townships with fair drainage including those with sandy beach ridges or bordering the Maumee River. This adds support to the relatively widespread belief that heavy rains causing flooding of flat and poorly drained fields containing pheasant nests was one of the important factors of the pheasant decline.

Table 1 shows the average number of nests reported per 100 acres of hay in Henry and Wood Counties during the pre-war and the postwar periods.

Table 2 classifies the number of townships in these two counties according to the percentage of decrease in hay field pheasant nests from the pre-war period to the post-war period.

ords were kept of the number of pheasant nests reported for various cover types. These records are summarized as three-year averages in Table 4. According to the farmers reports the first cut-

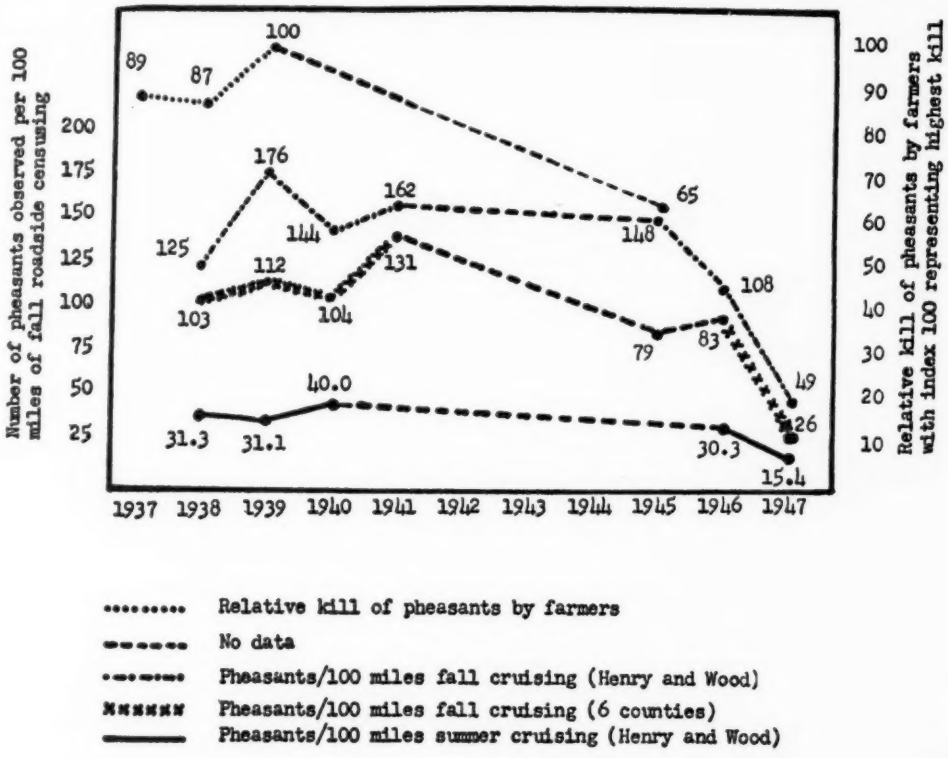

FIG. 3b.—Pheasant Population Trends as Determined by Roadside Counts and Kill Data.

PHEASANT NESTING DENSITIES ACCORDING TO COVER TYPES

Pheasant nesting densities reported by farmers in the Henry-Wood County area are shown for the first cutting of alfalfa and for other hay crops grouped together in Table 3. Note that more nests were observed per 100 acres in alfalfa than in the other hay crops each year except in 1946.

During the 1938 to 1940 surveys, rec-

ting of alfalfa ranks number one as pheasant nesting crop cover followed by red clover, mixed hay, alfalfa (second cutting), sweet clover, wheat and oats.

Individual fields of practically all hay types, however, were found to have high nesting densities of pheasants if located near winter pheasant concentration areas. Clover fields left undisturbed until cut for seed were outstanding in this respect. For example, Strode and Leedy

TABLE 1.—PHEASANT NESTS REPORTED PER 100 ACRES OF HAY MEADOW IN HENRY AND WOOD COUNTIES

Number of pheasant nests reported per 100 acres of hay	Number of townships in each nesting density category	
	Pre-war 1937–1940	Post-war 1946–1947
1 to 10 nests	3	5
11 to 20 nests	4	10
21 to 30 nests	6	7
31 to 40 nests	5	6
41 to 50 nests	5	1
51 to 60 nests	5	0
61 to 70 nests	1	0
71 to 80 nests	1	1

(mimeographed Release No. 135) found in 1939 by careful search, 123 pheasant nests in one 25-acre sweet clover field adjacent to a pheasant refuge. The sweet clover field was examined at the time it was cut for seed, late in the season. Most of the nesting was completed, hence a high percentage of the eggs in these nests was successfully hatched prior to cutting.

Errington and Hamerstrom (1937), Randall (1940) and others, including the author, have found that pheasant nests started in late May and early June were most successful. Thus cover to be utilized as a nesting site by pheasants should be available early in the season and possess sufficient height and density to satisfy the requirements of the birds. One possible explanation for the apparently greater utilization of alfalfa than other hay crops is that it makes a rapid growth early in the spring; another reason might be that fields of alfalfa average somewhat smaller in size than other fields and are probably better distributed per unit of area in their proximity to pheasant wintering sites.

Farmers reported on pheasant nesting in 51 fields totalling 574 acres after having mowed the fields twice (first and second cuttings). They observed 28.4 nests per 100 acres during the first cutting and 4.7 per 100 acres during the second cutting

Fields which remain in alfalfa for more than one year appear to be used less for pheasant nesting than first year fields. Strode (1942) reported that the number of pheasant nests found per 100 acres of alfalfa declined from 126.2 for first year meadows to 73.4 for second year meadows to 45.9 for third year meadows. These findings are based on seven fields of each type totalling 179.3 acres. This is contrary to the findings of Buss (1946) who reported that the pheasant nesting density in Wisconsin was greater in old hay fields than in first year fields. It is possible that the distances of the various fields from wintering pheasant concentration areas may have affected the results of one or both of these studies.

As pointed out by Leedy and Dustman (1947), first year hay fields con-

TABLE 2.—REPORTED DECREASE IN HAYFIELD PHEASANT NESTING DENSITIES IN HENRY AND WOOD COUNTIES FROM THE 1937–1940 PERIOD TO THE 1946–1947 PERIOD*

Percentage of decrease in hayfield pheasant nests	Number of townships classified according to percentage of decrease
0–10 per cent	3
11–20 per cent	3
21–30 per cent	7
31–40 per cent	8
41–50 per cent	4
51–60 per cent	1
61–70 per cent	2
71–80 per cent	1

* These pheasant nesting densities are based on the average number of nests reported per 100 acres of hay meadow by townships 1937–1940 and 1946–1947.

TABLE 3.—NUMBER OF PHEASANT NESTS REPORTED IN ALFALFA AS COMPARED WITH OTHER HAY CROPS, HENRY AND WOOD COUNTIES, 1937 TO 1947

Year of Survey	Alfalfa			Other Hay			All Hay		
	Number of acres	Number of nests reported	Average number per 100 acres	Number of acres	Number of nests reported	Average number per 100 acres	Number of acres	Number of nests reported	Average number per 100 acres
1937	—	—	—	—	—	—	4,432	1,124	25.4
1938	2,532	977	38.6	3,970	1,066	26.9	6,502	2,043	31.4
1939	3,638	1,419	39.0	3,351	1,256	37.5	6,989	2,675	38.0
1940	3,832	1,564	40.8	4,564	1,715	37.5	8,396	3,279	39.1
1946	4,305	1,511	35.1	1,888	3,170	16.7	6,193	1,828	29.5
1947	6,062	702	11.6	2,775	399	14.4	8,837	1,101	12.5
Totals	20,369	6,173	30.3	16,548	4,606	27.8	41,349	12,050	29.1

taining the unclipped stubble from the previous season's small grain crops are more utilized as pheasant nesting sites than first year hay fields in which the grain stubble has been clipped.

PHEASANT NESTING SUCCESS ACCORDING TO COVER TYPES

Pheasant nesting success in crop fields is closely related to the percentage of nests which have hatched prior to the harvesting (Table 4). Needless to say, practically all unhatched nests that are mowed over are failures due to the fact that the eggs are usually broken by the harvesting equipment or taken by predators (primarily crows) or because the hen is killed or deserts the nest.

Generally speaking, the later the harvesting date, the higher the percentage of successfully hatched nests in a given cover type. Unfortunately the peak of

TABLE 4.—PHEASANT NESTING ACCORDING TO COVER TYPE, OHIO PHEASANT BELT 1938–1940 (3-YEAR AVERAGE)

Cover types	Number of acres cut	Number of pheasant nests reported	Average number of nests per 100 acres	Percentage of nests hatched at time of cutting	Relative no. of nests per 100 acres: index 100	Relative no. of pheasant casualties per 100 nests mowed over*	Approximate peak periods of harvesting the crops
Alfalfa (1st cutting)	28,483	5,947	20.8	21.5	100	100	June 15
Alfalfa (2nd cutting)	887	92	9.5	28.4	46		July 20
Red clover	20,304	2,834	14.1	32.7	68	80.5	June 25
Mixed hay	53,982	5,509	12.3	41.8	59	74.8	June 25
Timothy	8,261	522	4.8	51.4	23		June 30
Sweet clover	3,739	384	8.8	58.5	42		June 20
Wheat (binder-cut)	69,972	1,260	1.7	72.5	8	14.7	July 5
Wheat (combined)	16,838	311	1.8	71.1	9		July 15
Oats (binder-cut)	7,559	60	0.8	60.2	4		July 15

* Samples of the second cutting of alfalfa, timothy, sweet clover, combined wheat and oats are considered too small for indicating relative pheasant casualties due to harvesting.

the mowing period for the first cutting of alfalfa occurs at about the peak of the pheasant nesting season resulting in very high losses of both nests and incubating hens. Only about one-fifth of the nests reported in the first cutting of alfalfa have hatched at the time of harvesting compared with about three-fourths of the nests in wheat. An average of approximately three-fifths of the oat field nests had hatched at the time of harvesting during the 1938–1940 surveys. This percentage, lower than that in wheat even though the cutting date is later, may be due to the smaller sample involved or possibly to the fact that the oats do not provide adequate nesting cover until late in the season, with the result that most of the pheasant nests in oat fields may represent re-nesting attempts.

It should be pointed out here that due to the greater nesting success rates in small grains these grain fields may result in more pheasants produced than hay fields with a larger number of nests. Usually, however, the greater nest densities found in hay more than offset the lower percentage of successful nests in this cover type.

It is interesting to note that farmers, when asked what percentage of all pheasant nests they thought were located in hay, reported that from about one-third to three-fourths of the nests were in this cover type. The smaller percentage of hay field nests was reported in Fayette, Greene and Ross Counties approximately 100 miles south of the present center of pheasant abundance in Ohio, whereas the higher percentage of hay field nests was reported in the heart of the pheasant belt. In their intensive nesting studies Strode (1942) and Dustman (unpublished notes) found that about two-thirds of all pheasant nests were located in hay.

In north-central Iowa, Baskett (1947) also found that hay fields contained from 34.6 to 64.8 per cent of all nests and that as nesting densities in a given area increased, the proportion of hay field nests increased.

PHEASANT CASUALTY RATES ACCORDING TO COVER TYPES

Pheasant casualty rates due to mowing were reported to be highest in the first cutting of alfalfa followed by red clover and mixed hay (Table 4). Note that in the 1938 to 1940 period there were less than 15 per cent as many pheasant casualties per 100 nests cut over by a binder as in the first cutting of alfalfa. As pointed out by Leedy and Dustman (1947), pheasant casualties due to mowing of hay increased more than 60 per cent (from 27.8 per 100 nests mowed over to 44.7) during the 1938 to 1946 period, primarily due to the increased use of power mowers; whereas casualties in wheat decreased by about three-fourths, from 11.6 to 2.8 in the same period, due primarily to the increased use of combines. Approximately 20 per cent of the wheat was cut by combines in 1938 as compared with 80 per cent in 1946.

OTHER INFORMATION COLLECTED DURING THE NESTING SURVEYS

Among the other data collected on the extensive pheasant nesting surveys were (1) information on the relative abundance of various game animals, (2) game bagged by farmers, and (3) the percentage of farmers who hunt. Only such supplemental information as per-

tains to pheasants and hunters is included in this report.

In 1938, when asked to compare the pheasant population with that existing in 1937, approximately 77 per cent of the Henry and Wood County farmers interviewed, reported increases. In 1946 when asked by the game protectors to compare 1946 pheasant numbers with those existing in 1941, approximately 86 per cent reported decreases.

In the pre-war period approximately two-thirds of the farmers interviewed in Henry and Wood Counties hunted as compared with 48 per cent in 1945. The lower percentage of farmers hunting in 1945 is probably due to the fact that many of the younger men had not yet returned from the armed forces. The lower percentage of farmer hunters in 1945 together with the smaller season bag (5.8 in 1945; 6.3 in the pre-war period) resulted in a farmer kill of pheasants only about 65 per cent as high as that reported in 1939.

SUMMARY

1. An extensive type of pheasant nesting study, based on personal interviews with approximately 7 per cent of the farm operators in each township, is described.

2. The number of pheasant nests reported per 100 acres of hay meadow mowed provides an index to relative pheasant populations and their distribution.

3. Decreases in pheasant numbers are indicated for all but one of the townships in Henry and Wood Counties, Ohio, from the pre-war period (1937 to 1940) to the post-war period (1946 to 1947). An increase in pheasants is shown for one township.

4. Population trends based on the extensive nesting survey described, compare favorably with the data obtained from intensive nesting studies, roadside pheasant counts and hunter kill reports.

5. The average number of pheasant nests reported per 100 acreas was highest for alfalfa (first cutting) followed by red clover, mixed hay, alfalfa (second cutting), sweet clover, wheat and oats.

6. Individual fields of practically all hay types were found to have high nesting densities if located near winter pheasant concentration areas.

7. The first cutting of alfalfa contained more than six times as many nests per unit of area than the second cutting of alfalfa.

8. Second and third year alfalfa fields were found to have less nests per unit of area than first year alfalfa fields.

9. Pheasant nesting success in crop fields is closely related to the percentage of nests hatched prior to the harvesting.

10. Only about one-fifth of the nests reported in the first cutting of alfalfa have hatched at the time of harvesting compared with approximately three-fourths of the nests in wheat.

11. Based on the number of nests cut over, pheasant casualty rates due to harvesting machinery were less than 15 per cent as high in wheat as they were in the first cutting of alfalfa.

12. Other data collected during the extensive nesting studies included information on the relative abundance of game animals, percentage of farmers who hunt and the amount of game bagged.

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BAND RETURNS FROM MALE RING-NECKED PHEASANTS IN NEW JERSEY[1]

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In the summer of 1946 the New Jersey Division of Fish and Game inaugurated a program of banding all liberated game birds. The purpose of banding ring necked pheasants (*Phasianus colchicus torquatus* Gmelin) was to obtain data on the number of banded birds killed and reported by hunters, the age and time of the year at which a bird should be liberated to yield the maximum return, the variation in kill by counties, the number of liberated birds that survive through a hunting season, the value of proper habitat in survival, and the difference in returns of liberated birds produced by the State-owned and privately-owned game farms.

As part of this program, all ring-necked pheasants were banded with an aluminum, butt-end band that contained the inscription "Notify N. J. Div. of Fish and Game, Trenton" and a number. Losses of bands by pheasants is believed to be negligible. Buss (1946) showed, through field experimentation, that good aluminum bands are not lost.

Each band number was recorded and a notation made of the sex, source (State or private game farms), age, and point of liberation. When a band was returned, the record was completed on the bird as to the date and cause of death, the date of band return, and the amount of drift from the point of liberation. Data on female pheasants were very limited and for the purposes of this article the returns on 16,219 male birds will be analyzed.

ANALYSIS OF DATA

As field liberations ranged in number from one to fifteen birds, it was not found practical to organize the data on this basis for the results desired. Consequently, the band returns from the 16,219 male pheasants were analyzed by segregating the birds into separate liberations on the basis of the date of liberation, age in weeks, source of birds, and county in which the pheasants were liberated. In addition, the above data were further separated as to whether the birds were released on privately-owned open hunting lands throughout

[1] The writers are indebted to Mr. J. D. Darroch, Statistical Laboratory, Iowa State College, for analyzing the statistical methods employed.

TABLE 1.—DISTRIBUTION OF 16,219 PEN-REARED MALE PHEASANTS LIBERATED IN THREE DIFFERENT TYPES OF HABITAT IN NEW JERSEY IN 1946

	Open lands	State lands	
		Checking stations maintained	Checking stations not maintained
Number of liberations	297	21	23
Range in birds per liberation	4 to 300	15 to 120	4 to 100
Mean number of birds per liberation	47.3 ±2.0	62.8 ±7.2	37.0 ±4.6
Standard deviation of the mean	34.9 ±1.4	33.1 ±5.1	22.1 ±3.3
Total number of birds liberated	14,050	1,319	850

the State, on public shooting grounds owned by the State where checking stations were maintained to obtain the bands, or on public shooting lands owned by the State where no checking stations were maintained to collect the bands from birds killed during the open hunting season. For the sake of clarity and avoidance of needless lengthy repetition, privately-owned open hunting grounds will be referred to as open lands and State-operated public shooting grounds as State lands. All 16,219 male pheasants were actually released in the field. The few birds that died enroute to a liberation point were not considered.

Table 1 gives the number of liberations, mean number of birds per group, standard deviation of the mean, range in number of birds per liberation, and the total number of birds released in each of the three different types of areas.

BAND RETURNS

Table 2 summarizes the band returns. The pheasants released on open lands had a total band return of 8.0 per cent which is comparable to band

TABLE 2.—BAND RETURNS ON 16,219 PEN-REARED MALE RING-NECKED PHEASANTS RELEASED ON OPEN STATE LANDS IN NEW JERSEY IN 1946

	No. of birds Banded	No. of Banded Birds shot and reported	Percentage of Banded Birds shot and reported	No. of Banded Birds killed by accident or predators and reported	No. of Banded Birds killed by an unknown factor and reported	Percentage of Banded Birds killed by means other than hunting and reported
Pheasants released on open hunting lands	14,050	1,031	7.3%	24	68	0.7%
Pheasants released on State lands	850	173	20.3%	2	0	0.2%
Pheasants released on State lands and checking stations maintained	1,319	552	41.8%	4	1	0.3%
Total	16,219	1,756	10.8%	23	69	0.6%

returns from Ohio (Olds, 1940), Indiana (Ginn, 1947), Wisconsin (Kellog, 1939), Pennsylvania (Gerstell, 1938), and Massachusetts (Wandell, 1945).

Pheasants released on State lands showed a total return of 20.5 per cent. This higher return was partly due to the date of liberation, but the main reason is believed to be the better pheasant habitat on the State lands than on the unmanaged open lands. The apparent importance of habitat will be discussed in greater detail later. As was expected, the returns from pheasants released on State lands where an effort was made to collect bands had the highest return, 42.1 per cent.

Losses, as determined by band returns, from predators, accidents, and unknown causes were not excessive (Table 2); however, it must be remembered that returns from bands on pheasants lost through means other than hunting were likely to be few in number.

Only two (0.01 per cent) bands from the total of 1,756 bands reported were obtained in 1947, which implies a very low survival of stocked pheasants from the first to the second open season. This fact has been noted by Gerstell (1938) in Pennsylvania where 1,983 mature cocks were released from which 380 (19.1 per cent) were killed during the first season and 14 (0.7 per cent) the second season on class one and two range. Wandell (1945) studied 6,363 banded cocks liberated in 1943 in Massachusetts and obtained bands from only seven (0.1 per cent) of the pheasants in the 1944 season. Buss (1946) studied the survival of 5,196 pheasants released in Wisconsin on shooting preserves and public shooting grounds and found that 768 (14.8 per cent) were killed the first year and 17 (0.3 per cent) were shot the second shooting season. Consequently, the survival of penreared pheasants from the first to the second hunting season based on bands returned from 27,592 birds is less than one per cent.

TIME OF RELEASE

As other workers have found an association in band returns between the date of release and the opening of the hunting season, the band returns from the open lands in New Jersey were analyzed for such a possible relationship. Figure 1 is a graphic representation of the average per cent band returns on 14,050 pheasants released during the various periods on open lands. The variations in band returns from July 15 to October 16, 1946, may be due to the small number of liberations for the individual period, age of birds, source, and/or type of habitat in which the birds were released. From the period October 16 through December 10, 1946, there appears to be a significant difference in the mean per cent of bands returned, as compared to per cent band returns previous to this date. As would be expected, the highest returns were from those cocks released during the open season. Consequently, one could interpret these data as indicating that the returns from the pheasants stocked during and up to three weeks prior to the open season were greater than for any other period analyzed in this report. This is supported by the fact that the stocked birds have less chance to perish from accidents, predation, and unknown causes. Buss (1946) in Wisconsin studied 1,249 pheasants released on various shooting preserves that had not less than 35 and

as long as 110 days to go wild, wander, or die before the shooting season opened, and he found a kill of 141 birds or an average of 11 per cent with a range of 0 to 27 per cent. In another group of 1,027 pheasants released a day prior to the open season, 416 (41 per cent) were killed with a range from 2 to 81 per cent

lands in New Jersey. In order to eliminate the effect of dates of release on band returns as completely as possible, the 81 releases (approximately 3,830 birds) made from October 16 through December 10, 1946 were not considered (see Figure 1). From the remaining 216 liberations, three (approximately 140

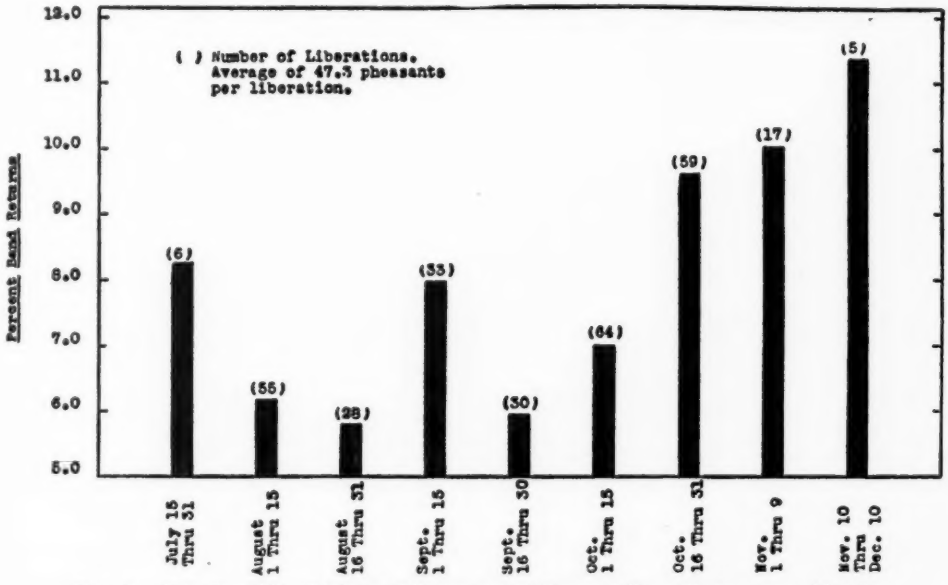

FIG. 1.—Relationship of Time of Release and Percent Band Returns on 14,050 Pen-reared Pheasants in New Jersey in 1946.

on the various preserves. Other workers in Pennsylvania (Gerstell, 1938) and Indiana (Ginn, 1947) have shown that the shorter the period of time between release and open season, the higher the band returns.

AGE OF RELEASE

As an apparent age difference in survival has been indicated by band returns in Massachusetts (Wandell, 1945), it was decided to analyze the relationship between age and per cent band returns on the pheasants released on open

birds) were discarded in the 22 and 23 weeks of age group as not being of sufficient number for analysis.

The remaining 213 releases (approximately 10,080 pheasants) were on birds from 10 to 20 weeks of age and on birds more than one year old. Figure 2 is a graphic presentation of the data and inspection of the graph reveals no apparent significant difference or statistical relationship in the band returns on the pheasants from 10 through 20 weeks of age. The slight differences (less than 2.0 per cent) among the age groups were

probably due to the habitat in which the birds were released and partly to the source of the birds. The adult birds, however, based on 12 liberations were 1.79 per cent below the average (6.57 per cent) for the 10 to 20 week age groups. This may indicate that adult birds are not able to acclimate themselves to a wild habitat as readily as young birds.

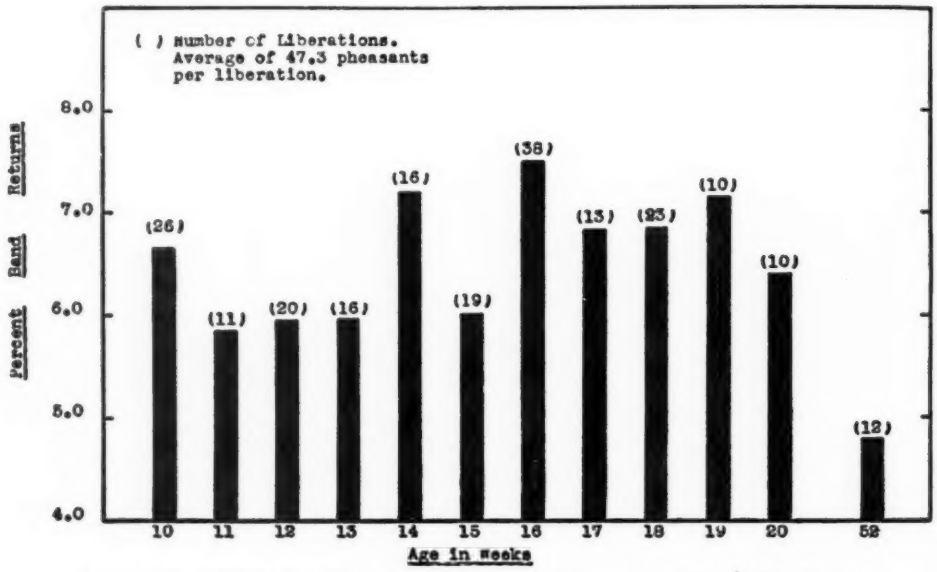

FIG. 2.—Relationship of Band Returns from Approximately 10,080 Pen-reared Male Pheasants and Age in Weeks at time of Release in 1946.

LOCATION OF RELEASE

In order to study the sectional habitat differences in band returns, the releases were analyzed by county. Only 18 of the 21 counties in New Jersey contained enough releases for evaluation. At least five liberations (approximately 235 birds) were considered necessary in a county for inclusion in the analysis.

Table 3 illustrates the variation in per cent pheasant band returns for the various geographical sections of the State of New Jersey. The importance of habitat to pheasants is again reiterated through the medium of pheasant band returns.

Northern New Jersey is composed mostly of forest areas and dairying is the chief agricultural vocation. The habitat for pheasants would be classified as poor with a few limited areas representing fair to good environment. North-central New Jersey has always been recognized as the best pheasant range in the State. This assumption, based on the habitat and natural pheasant population, is supported by returns from the area. The area maintains a relatively high human population and general farming predominates. The section contains a portion of the fertile Piedmont Plain, which also supports a high pheasant

population in Pennsylvania.

As was expected, southern New Jersey had a relatively low return with Cape May County showing the lowest return (3.52 per cent) for the State. The band returns from southwestern were comparable to north-central New Jersey. This area contains the Delaware River marshes, the fertile sassafras-collington soil area, and maintains an intensive type of agriculture. The pheasant habitat in this section would be classified as fair to good.

TABLE 3.—PERCENT BAND RETURNS FROM APPROXIMATELY 13,665 PEN-REARED MALE PHEASANTS LIBERATED IN 18 COUNTIES IN NEW JERSEY FROM JULY 15 THROUGH DECEMBER 10, 1946

County	Number of liberations	Approximate No. of birds	Percent Band returns
A. Northern New Jersey			
Sussex	25	1,180	5.11
Passaic	27	1,280	5.25
Bergen	19	900	3.66
Warren	31	1,470	6.24
Total	102	4,830	5.27 ±0.91
B. North-central New Jersey			
Morris	27	1,280	7.99
Hunterdon	32	1,510	9.95
Somerset	15	710	8.55
Mercer	11	520	11.31
Middlesex	20	945	8.05
Monmouth	18	850	9.61
Total	123	5,815	9.12 ±1.21
C. Southwestern New Jersey			
Gloucester	8	380	10.20
Salem	11	520	8.40
Total	19	900	9.69 ±1.05
D. Southern New Jersey			
Atlantic	5	235	4.95
Cumberland	9	425	4.73
Burlington	10	470	4.75
Camden	8	380	5.95
Cape May	7	330	3.52
Ocean	6	280	5.95
Total	45	2,120	4.52 ±1.01

area is geologically in the coastal plain section and is characterized by the "Pine Barrens" region of New Jersey. Farming is scattered except for restricted localities where truck farming is the major type of agricultural pursuit. This region has always been considered as poor habitat for ring-necked pheasants.

Statistical analysis of the data shows that there is a significant difference between the band returns for the four geographical regions ($F=21.35$, 0.1 level $=5.56$) and between north-central and southwestern as compared to southern

and northern New Jersey (F=64.04, .01 level=8.86). There was no statistically significant difference between counties in north-central and southwestern or northern and southern New Jersey.

The difference in band returns between the various regions in New Jersey was checked for the dates that the birds were released. However, no apparent difference was noted in dates of releasing birds in any of the four regions analyzed.

The importance of habitat to stocked pheasants has been stressed by other workers. Gerstell (1938) working in Pennsylvania released 2,986 mature male pheasants six weeks prior to the opening of the shooting season and had a 35.0 per cent band return on 1,347 pheasants in first class range, 15.9 per cent band return on 1,439 pheasants in second class range, and an 11.0 per cent band return on 200 pheasants in third class range. Leopold, Lee, and Anderson (1938) showed that wild pheasants trapped and stocked where food and cover were good did not disperse where-

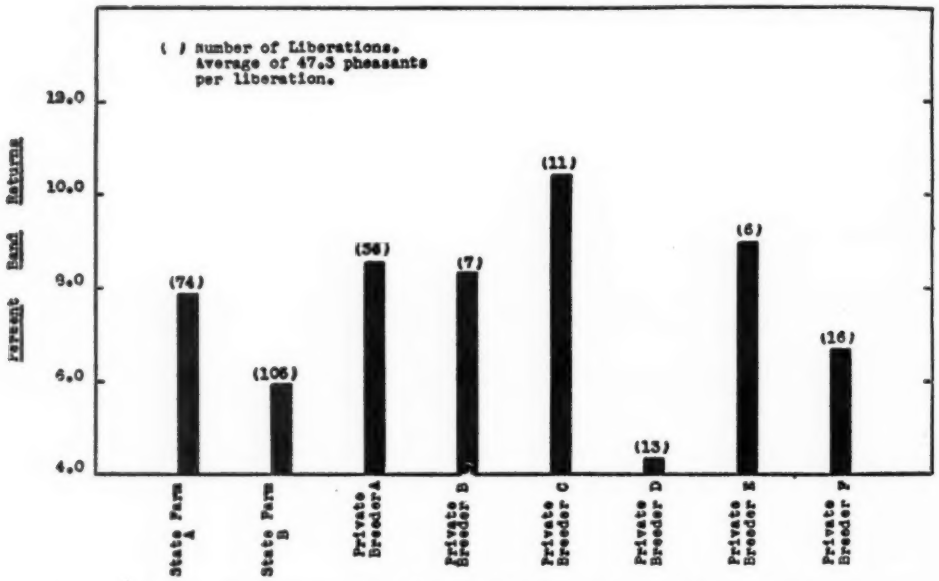

FIG. 3.—Per cent Band Returns on Approximately 8,405 State Pen-reared Pheasants and Approximately 4,210 Birds Purchased from Private Breeders in 1946.

as where food and cover were both poor, dispersion was immediate and complete.

The importance of habitat is further substantiated by the increase in per cent band returns from State lands that are managed primarily for wildlife. Table 1 shows a 20.1 per cent band return from State lands and only a 7.3 per cent band return from open lands. No special attempt was made to collect bands on this particular group of State lands, and the pheasants were stocked at approximately the same dates on both areas.

SOURCE OF BIRDS

During the summer of 1946 the New Jersey Division of Fish and Game reared pheasants at the State game farms and purchased birds from private breeders. Private breeders from which less than five liberations(approximately 235 birds) were purchased were eliminated from the analysis; consequently, 179 releases (approximately 8,460 birds) by two state game farms and 89 releases (approximately 4,210 birds) of pheasants from six private breeders were studied. The data are depicted in figure 3. Statistical analysis showed no significant difference in band returns between the State game farms or between the State farms and private breeders. One private breeder (D) had an average band return of 4.33 per cent on 13 liberations (about 615 pheasants), the majority of which were liberated in north-central New Jersey in our best habitat. Consequently, there is an indication of a varying ability of pheasants to survive in the wild, depending on the method employed to rear the birds by the breeder.

MOVEMENT OF RELEASED BIRDS

Data were available on 315 male pheasants for a study of drift. Birds released after November 1, 1946, were not considered, as the hunting season opened on November 10, 1946. Consequently, the 315 pheasants had 10 days or more to become adjusted to wild conditions.

About 50 per cent of the pheasants were shot within one mile and 98 per cent within ten miles of their release point. The maximum drift was 23 miles by one bird. Wandell (1945) in Massachusetts studied 881 male pheasants and found that 65.9 per cent of the pheasants moved less than one mile and 96.4 per cent drifted less than ten miles from the point of release to where the birds were killed.

Data on 406 pheasants liberated less than ten days prior and during the hunting season revealed that the birds all moved less than one mile. As the data were limited, no attempt was made to determine a relationship between movement and habitat quality.

DISCUSSION

The success of stocked birds depends on numerous factors and the evaluation of any one factor is difficult. In this study an attempt was made to evaluate such factors as age, time, place of release, and the source of birds. However, Buss (1946) has brought forth the effect of "violent releases" as compared to "gentle releases" and the condition of the bird prior to release as important factors in the success of liberated male pheasants. Consequently, the complete separation of one variable for an analysis with the equalization of the others is almost impossible unless the entire experiment is controlled. In analyses of band returns from pheasants liberated under uncontrolled experimental conditions, the differences that may exist in band returns due to various influencing factors have a tendency to be suppressed or distorted by the multitude of factors that determine the success or failure of a pheasant liberated in the wild.

The analysis of the data on the pheasant band returns would have been greatly enhanced if data were available on the number of banded birds shot for each one reported by the average hunter.

Such data would have enabled one to evaluate more accurately the percentage difference in band returns for the various influencing factors.

SUMMARY

1. Band returns were analyzed from 16,219 male pheasants liberated in New Jersey in the summer of 1946.

2. The per cent band returns reported for 14,050 pheasants liberated on open lands was 8.0 per cent.

3. There was an apparently higher band return from pheasants released during the hunting season or in the three weeks prior to the open season than from any other period.

4. No significant differences were noted in band returns for pheasants from 10 to 20 weeks of age liberated prior to three weeks before the open season. Limited data indicated the adult birds (more than 52 weeks old) were not able to acclimate themselves to a wild habitat as readily as young birds.

5. The type of habitat in which the pheasants were released appeared to govern the success of the liberation based on band returns more than any other factor.

6. There were indications of varying ability of pheasants to survive in the wild, depending on the source of the birds.

7. Data on 315 male pheasants liberated for at least ten days in the wild disclosed that about 50 per cent of the birds were shot within a mile and 98 per cent within ten miles of their release point.

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METHODS FOR THE DETERMINATION OF FOOD HABITS BY PLANT MICROTECHNIQUES AND HISTOLOGY AND THEIR APPLICATION TO COTTONTAIL RABBIT FOOD HABITS[1]

Julian L. Dusi[2]

As Baumgartner and Martin (1939) found in their study of squirrel food habits, gross analysis laboratory procedures are not satisfactory when applied to animals which finely masticate their food. They applied histological methods to identify the fine particles found in squirrel stomachs and have thus pioneered in this technique for food habits determination.

Unfortunately, the techniques used by them are not the most convenient ones and are difficult to apply in the examination of very finely-divided food habits materials. Therefore the writer developed a set of procedures which seem to be better adapted to the entire group of herbivorous animals whose food habits require histological analysis. These methods were tested primarily in the study of cottontail rabbit food habits by droppings and stomach analysis. They were also tested in the similar analysis of stomachs of rodents of the genera *Peromyscus*, *Microtus*, and *Mus*, and on the droppings of several lepidopterous larvae.

[1] The writer wishes to acknowledge with thanks the kind advice of Dr. Charles A. Dambach; the aid of Dr. Daniel L. Leedy and George A. Petrides of the Ohio Wildlife Research Unit, Ohio State University; and Dr. A. C. Martin, with whom he collaborated at the Patuxent Research Refuge.

[2] Research Fellow, the Ohio Wildlife Research Unit: the Ohio Division of Conservation and Natural Resources, the Ohio State University, the U. S. Fish and Wildlife Service and the Wildlife Management Institute cooperating.

Microtechnical Procedures

Microtechnical procedures require the preparation of reference material and food habits material.

Reference material, especially, must be well prepared. It was found important in making a study based on histological techniques that all procedures, from making field collections to the final food plant determination, be carried out with great accuracy. A mistake such as the misidentification of a reference plant, when once made into a reference slide, could bring about a great error which might be very difficult to ascertain and to rectify.

Since food habits determinations by histological methods are rather tedious, it was found best to begin the identification by listing the herbaceous plants which might be important as foods in the habitat from which the animal or its feces was taken. Thus the number of reference plants was kept at a minimum.

The study of rabbit food habits by means of fecal pellet analysis illustrate the methods used. Rabbit pellet analysis is useful for two reasons: 1) fecal pellets are easier to collect and store than stomachs; and 2) a continuous collection of pellets can be taken from the

same rabbit population, since the rabbits are not killed.

It was found that in stomach and fecal pellet materials, the plant tissue which was most abundant and which fortunately possessed suitable characters for identification, was the epidermis. Therefore plants which might be used by the rabbits for food were collected and reference slides were made from their epidermis. A number of procedures were used for making these slides. The following two were found easiest to use and most suitable for all herbaceous material.

From plants whose epidermis could be mechanically removed, slide mounts were prepared by a procedure developed during the course of the study. This was done by the following directions.

1. Strip pieces of epidermis from the leaves of plants freshly collected.
2. Kill the tissue by immediately placing it in 100 per cent ethyl alcohol for ten minutes.
3. Pass the tissue down through an ethyl alcohol series, 95, 70, 50, and 35 per cent, at intervals of ten minutes each.
4. Stain the tissues in Mayer's Haemalum to a density which is slightly darker than the finished mount should be. This requires from 15 minutes to several hours. Johansen (1940) describes the stain.
5. Rinse out surplus stain in tap water.
6. Mount the tissue, outer side up, in Apathy's gum syrup. Richards (1943) describes this mounting medium.

From plants whose epidermis could not be mechanically stripped-off, maceration slide mounts were made. This was done as follows:

1. With a sharp scalpel, cut the leaves of freshly collected plants into sections $\frac{1}{8}$ to $\frac{1}{4}$ inch square.
2. Kill and fix the material immediately in Formalin-Aceto-Alcohol. Johansen (*op. cit.*) provides the formula.
3. Rinse the material in tap water and then place it in a vial with equal parts of 10 per cent nitric acid and 10 per cent chromic acid, freshly mixed.
4. Place it in a warming oven at about 40°C. The maceration time varies from 6 to 24 hours.
5. Check the material occasionally to determine the point at which the material may be teased apart.
6. At this point, remove the material from the maceration solution and rinse it in tap water.
7. Stain the material in Mayer's Haemalum.
8. Rinse it in tap water to remove excess stain.
9. Place a small piece of material on a clean slide and tease it into fine particles with a dissecting needle.
10. Mount it in Apathy's gum syrup.

In order to obtain the greatest value from the reference slides, photomicrographs were made. These were much easier to handle than microscope slides and could be filed like reference cards. They reduced the amount of microscope work and greatly speeded up the process of making food determinations.

Two types of photomicrographs were made: 1) black and white; and 2) color transparencies. Black and white photomicrographs were used for reference in making determinations. Color transparencies used in a viewer were less

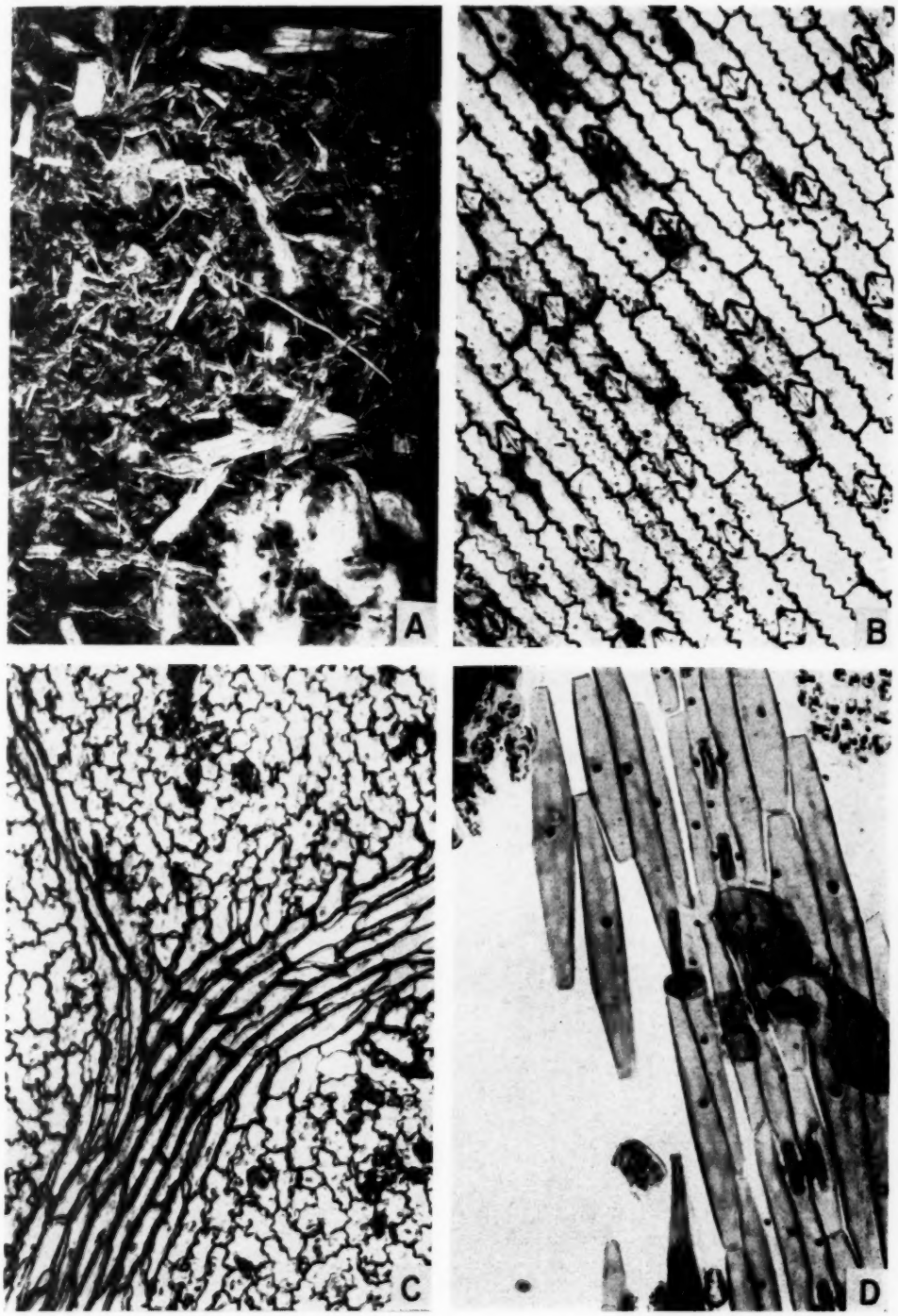

PLATE 10, A. A photomacrograph of crushed rabbit fecal pellet material magnified about 45 times. It appears thus when observed under a stereoscopic binocular by the usual methods employed in making gross analyses. B. A photomicrograph of epidermis of *Zea mays* magnified about 110 times. A typical monocot. C. A photomicrograph of *Cichorium intybus* epidermis magnified about 110 times. A typical dicot. D. A photomicrograph of a fragment of *Dactylis glomerata* as it appears in rabbit pellet material magnified about 110 times.

useful for making food determinations. Black and white prints were of further use for publication, while the color transparencies were used as teaching aids.

Fecal pellet material must be mounted on microscope slides for histological analysis. It was found that a slight amount of clearing was necessary in order to see cell structure. Also, a statistical analysis showed that sufficient homogeniety existed in a pellet, so that only a small portion need be taken as a sample. From these the following mounting procedures were developed.

1. Place a small portion of a pellet upon a clean microscope slide.
2. Add a drop or two of 100 per cent alcohol and separate the material into very small particles with a dissecting needle.
3. Displace the alcohol with several drops of xylene and mix it with the particles.
4. Examine the slide under a compound microscope (at about 100 x) to see whether the material has cleared enough to show cell structure.
5. If the material is sufficiently clear, add several drops of clarite, distribute the particles over an area about $\frac{3}{4}$ inch square and add a coverslip of that dimension.
6. If the material in the above process did not clear sufficiently, prepare a new slide as in step one and then add two drops of chloral hydrate solution (6.3 cc. concentrated HCl in 50 cc. H_2O plus 90 grams chloral hydrate crystals).
7. Warm the slide until the liquid has nearly evaporated. If not clear, add more solution and heat again.
8. When reasonably clear, add a drop or two of Apathy's gum syrup, spread the material evenly over the slide and put on a coverslip.

ANALYTICAL PROCEDURE

Fecal pellets were collected and stored in coin envelopes on which data were recorded as described by Davison (1940). Only fresh pellets were collected. These could be distinguished by their smooth, glossy, mucous coating from pellets which were several days old, since the mucous easily weathers away.

In general, it was found that the contents of each of the several fecal pellets of rabbits in a droppings pile was like its associates, unless the pellets varied greatly in color, shape, and size. Therefore as an arbitrary amount, no more than ten pellets were collected from each dropping pile.

Further statistical testing showed that an adequate sample consisted of a small portion of a pellet broken into particles, spread evenly over a microscope slide and covered with a $\frac{3}{4}$ inch square coverslip. For an average sized pellet, this consisted of about $\frac{1}{8}$ of the pellet.

After the pellet material was mounted on microscope slides, it was examined under a compound microscope. By use of a mechanical stage the entire area of the coverslip was traversed and each particle found was examined and if possible identified by comparison with reference photomicrographs and microscope slides. The identified particles were recorded and treated by frequency of occurrence methods.

After these procedures were developed, they were tested by applying them to determine the winter food

habits of a small group of cottontails and were used to confirm the utilization of some food plant plantings made by the Ohio Division of Conservation and Natural Resources. As one instance, the utilization of hairy vetch, *Viccia villosa*, was questioned. Microanalysis revealed that the pellets contained no other food than the vetch, showing definite utilization of the planting.

SUMMARY

Because histological food habits techniques already in existance were not easily applied to many animals whose food habits necessitate histological analysis, the writer attempted to develop other basic microtechniques for making these studies.

Methods for the preparation of reference microscope slides and photomicrographs and for the mounting and study of food habits slides are given.

Figures illustrate histological methods and some of the striking differences in plant epidermal cells upon which foods identification is based.

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PROBLEMS IN CALCULATING SIZE OF FISH AT VARIOUS AGES FROM PROPORTIONAL MEASUREMENTS OF FISH AND SCALE SIZES

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NECESSITY OF CALCULATING SIZE OF FISH FROM ITS SCALES

A most important requisite to understanding biology of a fish is knowledge of the growth rate characteristic of the population under various conditions and in different years. In general, determining the growth rate consists of obtaining the age of fish of a large range of sizes, and relating size to age. In many investigations the data on the average size that are available are incomplete or inadequate, because:

1. It is not always possible to obtain a large or a random sample of fish of certain sizes and ages. Many investigations are limited to obtaining fish of legal or commercial size, and these sizes usually exclude one or more age groups entirely, and also give a nonrandom representation of the smallest age groups that are included in the legal or commercial sampling.

2. It is difficult to obtain comparable points in the fish's history: i.e., the average lengths of 3-year-old fish increases throughout their third year of life; and in order to compare the lengths of 3-year-old fish in various years or areas, all lengths and scales must be

taken at the same time of the year.

3. In beginning an investigation, it is often desired to determine the size that fish of various ages were in past years during which no scales were collected.

In view of these conditions, it has been found necessary in many investigations to estimate the size of fish at young ages from measurements of scales of older fish.

The various terms required for this estimate are:

L = length of fish when scale was removed

S = length of scale radius when scale was removed

s_i = length of scale radius to annulus i (age i years)

l_i = length of fish when annulus i was formed (age i years)

where i can take values up to the age of the fish involved. Plate 11, A, indicates measurements of s_i and S.

TYPES OF FISH-SCALE RELATIONSHIPS

To estimate correctly size of fish from fish and scale measurements, it is necessary to know the relationship that exists between the two variables, size of fish and size of scale. There are four general types of relationship that may exist between the two variables:

Type 1. A straight-line relationship with zero intercept on the X axis.

Type 2. A straight-line relationship with an intercept of appreciable value.

Type 3. A series of straight lines over the range.

Type 4. A curvilinear relationship.

Type 1

The first type is the simplest and most convenient, for it permits easy calculation of l_i by the simple proportion:

$$\frac{\text{length of scale radius to annulus } i\ (s_i)}{\text{total length of scale radius } (S)} = \frac{\text{length of fish when annulus } i \text{ was formed } (l_i)}{\text{length of fish at time scale was obtained } (L)}$$

or

$$\frac{S}{L}=\frac{s_i}{l_i} \quad \text{or} \quad \frac{L}{l_i}=\frac{S}{s_i}$$

which when solved for l_i gives the formulae:

$$l_i=\frac{s_i}{S}L \quad \text{or} \quad l_i=\frac{L}{S}s_i$$

These formulae have been used in many fishery studies, often without proper justification. Some biologists have thought that the validity of this method of determining the length of a fish at successive years of its life depends, among other things, upon the following conditions: "... that the annual increment in the length (or some other dimension which must then be used) of the scale maintains throughout the life of the fish a constant ratio with the annual increment in body length." (Van Oosten, 1923)

With all straight-line relationships the increments of fish and scale sizes are proportioned to one another throughout the range of sizes. All straight-line relationships cannot, however, be used validly in the simple proportion formula, inasmuch as:

1. The formula requires that *attained sizes* and not merely *increments* be proportional; and,
2. The great majority of such lines

have porportional increments but not proportional attained sizes, inasmuch as they have an intercept other than zero, zero. With such an intercept it is mathematically impossible for the attained sizes of fish and scale to be proportional to one another throughout the range of sizes.

The valid use of the simple proportion formula depends upon a fish-scale relationship in which the ratio between the size of fish and the size of scale is the same throughout the complete range of sizes. These conditions are obtained when the relationship between fish and scale is a straight line, and when the intercept of this line, when "extended" to the axis, is zero. But they are not met when the relationship is a straight line with an intercept other than zero. This can be seen by an examination of Figure 1, which shows the general types of straight-line relationships: i.e., with zero intercept,

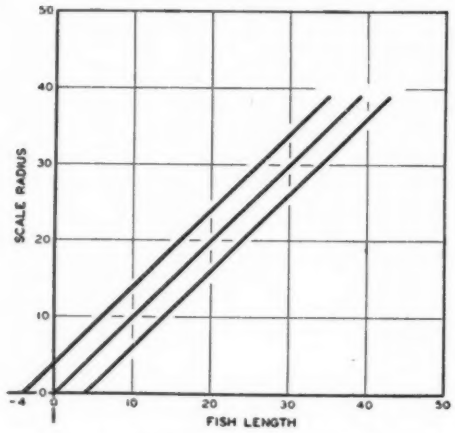


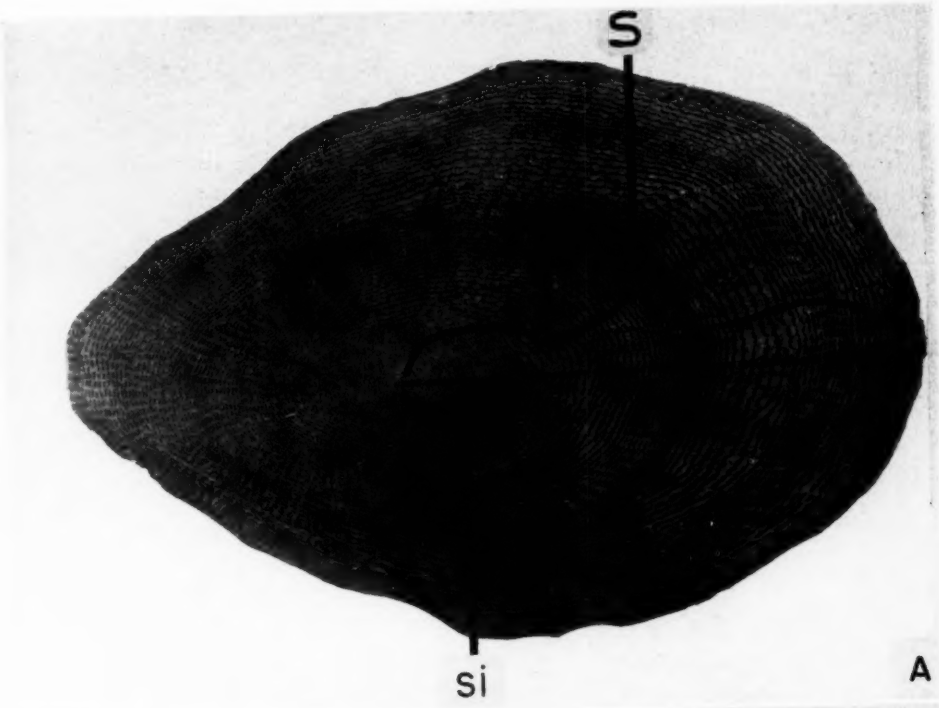
FIG. 1.—The three types of fish-scale relationships that may be expressed by a straight line: i.e., with 0 intercept, with a negative intercept on the X axis, and with a positive intercept on the X axis.

with negative intercept on the X axis, or with positive intercept on the X axis. In cases with an intercept of positive or negative value, the ratio between fish and scale is disproportionate throughout the complete range of sizes, and obviously, the formula which depends upon equal proportions of fish and scale sizes cannot be used.

A relationship with a zero intercept in fishery biology is rare. The usual straight-line relationship has a substantial intercept on the X axis, usually positive, sometimes negative. In many cases, however, the extent of the intercept has been assumed to be negligible and the formula has been utilized on the theory that equal ratios between fish length and scale length actually existed. In other cases, this formula has been employed with no knowledge of the relationship between fish and scale sizes. Frequently the extent of the intercept has been considerable and errors have been introduced.

In the case where the intercept on the fish-length axis is a positive value (Fig. 1), the ratios of L/S are decreasing constantly from small to large sizes of fish or scale: i.e., the scale is relatively larger in larger sizes of fish or scale. When the formula $l_i = (si/S)\ L$ is used, the resultant values of l_i are less than they correctly should be. On the other hand, with a relationship with a negative intercept on the fish axis, the scale is relatively smaller in larger sizes; and using this formula, incorrectly high values of fish length (l_i) are obtained.

Thus, the phenomenon of "apparent change of growth rate" (Lee, 1920) appears when the average length of one-year-old fish is calculated, using



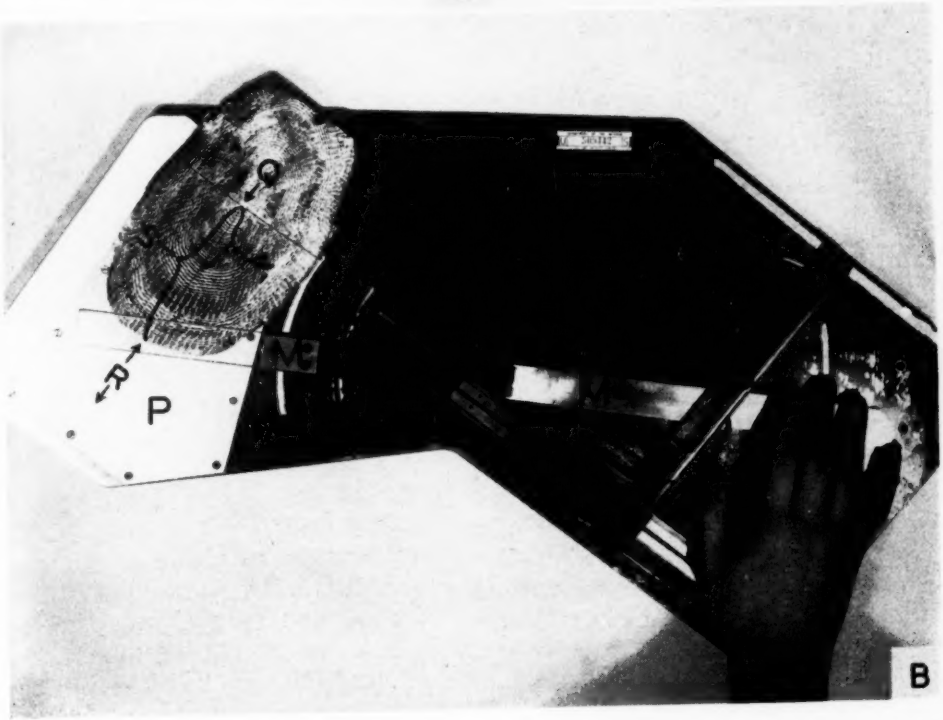


PLATE 11, A. Haddock scale illustrating proportional measurements. B. Fish-size calculator as used for the rapid calculation of fish sizes at various annuli from measurements of the scale radius to corresponding annuli.

scales from larger and larger fish. The effect is that, with a positive intercept, l_i decreases (increases with negative intercept) constantly as it is calculated from larger and larger fish. Although the phenomenon is probably not due entirely to the arbitrary use of this formula, such incorrect methods will cause an "apparent change in growth rate."

Type 2

The second general type of fish-scale relationship is that of a straight line with an intercept value other than zero. In this case, there are increasing or decreasing ratios of L to S. It can be seen from Figure 1 that if (in the case of a positive L intercept) this intercept, which may be denoted as C, is subtracted from each value of L, then the ratios of the resultant values of L to S are equal throughout the range. Thus, the simple proportion formula will apply, and it becomes:

$$\frac{s_i}{S}=\frac{l_i-C}{L-C} \quad \text{or} \quad l_i-C=\frac{s_i}{S}(L-C)$$

With a negative L intercept, the intercept value must be added.

The necessity of correcting for the intercept value has been recognized by many workers among which have been Brown, 1943; Walford and Mosher, 1943, etc.

The concept that the intercept is best represented by the size of the fish at the time the scale was first formed has been a popular one (Carlander and Smith, 1944; Lee, 1920; Merriman, 1941). However, ordinarily it is not necessary and perhaps not possible to calculate the length a fish had been before its first annulus was formed. Thus, it does not matter for ordinary purposes of fishery studies (1) what relationship actually exists between fish and scale up to the time the first annulus is formed, (2) what size the fish is when the scales are first formed, or (3) whether the scale forms as a point or as a plate of appreciable size. The relationship between fish and scale during the first year is completely inconsequential to the problem of back calculating to the first annulus. Thus the significance of intercept, obtained by extrapolating the straight-line relationship between fish and scale sizes for fish one-year-old and older need not be interpreted; it is enough merely that the intercept has value for calculating past lengths.

Types 3 and 4

The third and fourth general types of fish-scale relationship are those which are not best expressed by a straight line. In these cases, the line of best fit may be a curvilinear one, or it may be composed of a series of two or more straight lines along successive sections of the total range. In either of these cases, the proportional method of estimating l_i from s_i, S, and L, with or without adjustment for the intercept value, will not yield accurate results unless a table of corrections, or other means of correcting for non-linearity, is used (Creaser, 1926; Hile, 1941).

MECHANICS OF CALCULATING SIZE OF FISH FROM ITS SCALES

In reference to the actual mechanical operation of back-calculating, various methods have been used. Most entail:

(1) recording the size of scale at various annuli in some way; and, then,

(2) a separate operation of computing the sizes of fish corresponding to these sizes of scale.

With the realization that two such separate operations consume more time and probably introduce more mistakes than one combined operation, William C. Herrington designed a method of back calculation that did the complete job in one simple operation. The use of this "fish-size calculator" makes it unnecessary to record anything except the final desired result, i.e., the length of the fish at each annulus.

This calculator, as shown in Plate 11-B, consists of a movable arm (M) which can rotate about a pivot (N) and a sliding arm (O), upon which is etched a scale from 0 to 100. Assuming for the moment a relationship where $L/l_i = S/s_i$, the operation consists of these steps:

1. The image of the scale is projected by means of a microprojector upon the white celluloid plate (P) and aligned so that the focus is at point (Q) and the anterior radius extends along a line (R). (In actual operations, the projected scale image and all of the calculator would not be illuminated. For the purpose of showing all details in one figure, the set-up was "faked" to the extent of locating an actual photograph of a scale image on the white celluloid plate instead of an image itself.)
2. The rotating arm (M), which normally lies in a position perpendicular to the anterior radius and extending through the focus of the scale, is moved outward and on the arm placed at the edge of the scale, thus recording S, the total radius of the scale.
3. The sliding arm (O), upon which a scale from 0 to 100 is etched, is moved along runners (T) until the length of the fish at the time the scale was removed, L, appears over the line on the other end of the rotating arm (M).
4. Leaving the sliding arm in this position, the rotating arm is moved inward over the scale image until the line corresponds to the radius of the first annulus, s_i.
5. The calculated length of the fish at the time the first annulus was formed, l_i, is now read directly from the position that the other end of the rotating arm bears to scale on arm O.
6. The revolving arm is next moved outward, so that its line corresponds to the second annulus and the length of fish at annulus 2 is read off arm O and recorded, and so forth, until the fish lengths have been recorded at all annuli on the scale being examined.

In any case where $(S/L) = (S_i/l_i)$, a study of the proportional distances involved will show that the use of this calculator is valid.

The original calculator was constructed under the assumption of a straight-line relationship with an intercept at 0, *i.e.*, $(S/L) = (S_i/l_i)$. It can be, and has been, modified to take care of situations with a straight-line relationship with an intercept of positive value on the fish axis. This modification consists of subtracting the value of the intercept from the lower end of the graduated scale on 0. This graduated scale can slide to one side or the other and can be locked at any point by small screws. In order to correct for a positive

intercept of, for example, 3.5 centimeters, the scale would be adjusted so that the point 3.5 would correspond to the original position of zero.

With a negative intercept of 3.5 centimeters, the sliding scale would be moved to the right so that the 3.5 corresponds to the original position of 7.0.

The use of this calculator has resulted in a considerable saving in the time necessary to back-calculate lengths from several thousand haddock scales. At the present time, however, a further modification is being considered; *i.e.*, one in which a card is laid along the anterior radius of the image, and the location of the focus, each annulus, and the edge is marked by a simple stroke of a pencil. These cards are then to be turned over to a clerk who will place the card on the calculator in just the same position as the scale image itself would appear, and then make the necessary movements to estimate actual lengths of fish at the various annuli. It is thought that this modification, while increasing the clerical time only very slightly, will considerably decrease eye strain, amount of fatigue, and time spent at the microprojector; and will make it possible to read more scales in a given amount of time.

ACKNOWLEDGMENT

I wish to acknowledge William C. Herrington, formerly of the Fish and Wildlife Service, United States Department of the Interior, who developed the fish-scale calculator, and Drs. Lionel A. Walford and William F. Royce, Fish and Wildlife Service, United States Department of the Interior, who have critically reviewed the manuscript.

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THE EYEWORM, *OXYSPIRURA PETROWI*, IN NEBRASKA PHEASANTS[1]

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During April of 1941 the nematode eyeworm, *Oxyspirura petrowi*[2] Skrjabin 1929, was discovered in ring-necked pheasants, *Phasianus colchicus torquatus*, killed along highways in north central Nebraska. This parasite is circumpolar in distribution, being first described from Russian grouse. Cram (1937) reported it from sharp-tailed grouse (*Pedioecetes phasianellus*), prairie chickens (*Tympanuchus cupido*), ruffed grouse (*Bonasa umbellus*), robin (*Turdus migratorius migratorius*), and the eastern meadowlark (*Sturnella magna magna*) of North America, and it is known from several grouse of Europe and Asia.

Nebraska can be divided into two large regions; the sandhill grazing area north of the Platte River and west of the Elkhorn River; and the various hardland cultivated soils south of the Platte River and east of the Elkhorn River. There is considerable overlapping of the two regions. Pheasant populations were highest in the grain and corn growing lands of the northeast and in the cultivated borderlands of the sandhills. A low to medium population, up to seventy birds per section (640 acres) was fairly evenly distributed over the sandhills.

For the three year period, April 1941 to April 1944, highway kills throughout Nebraska were being examined as a part of a study of diet, seasonal weight changes and parasitism. A total of 386 dead pheasants were noted while traveling over 77,000 miles of Nebraska roads, mostly in the sandhills and borderland regions. Of these, 57 were examined for the presence of eyeworms. An additional 20 were examined at the Valentine Wildlife Refuge 20 miles south of Valentine, Nebraska. Eight were chicks and had no worms about the conjunctiva. It was assumed that chicks would not have been infected long enough for the parasites to appear in the eyes, although Fielding (1926) reported that it took only ten to thirty minutes for *O. parvovum* to reach the eyes in infected chickens. Only adults are considered in the further analysis of data given here.

Of 48 males 21 or 44 per cent had parasites about the eyes. Of 21 females six or 29 per cent were infected. This indicated a gross parasitism of at least 40 per cent. Plate 12 shows examples of this parasite. They were also found in both the sharp-tailed grouse and prairie chickens of the sandhills.

Since the birds were collected at all seasons of the year, the actual prevalence could be much higher, for we can assume that there are certain seasons when the worms are not present in the eyes or have not developed to infective stages in the secondary host. No data were obtained indicating the length of life of the parasite or the time spent in the eye. Although the number of speci-

[1] Work conducted under the direction of the Nebraska Game Forestation and Parks Commission, Paul T. Gilbert, Director.

[2] Species identified by Dr. H. W. Manter, Dept. Zoology, University of Nebraska.

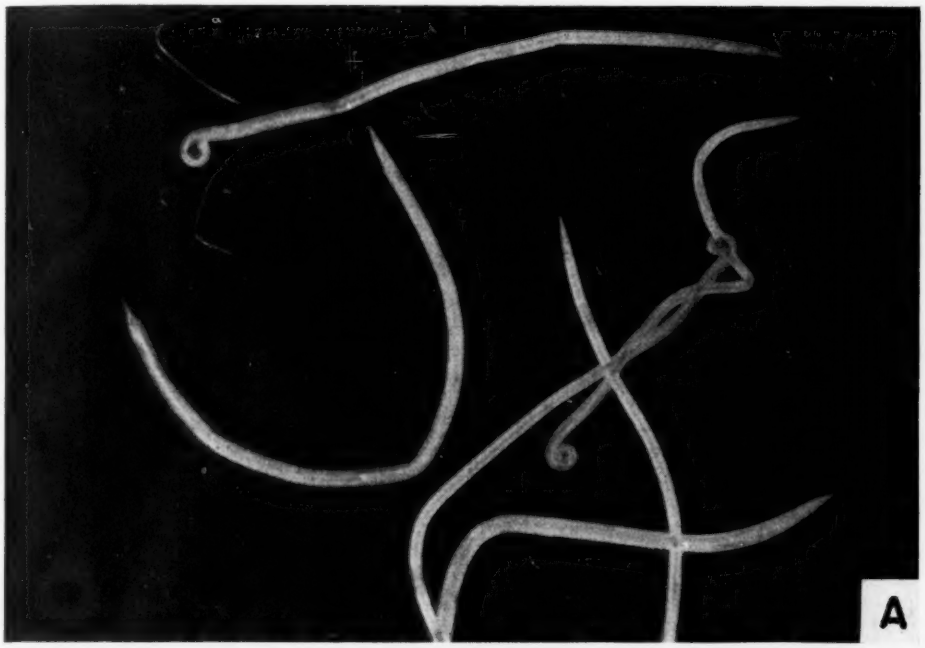

PLATE 12.—A. *Oxyspirura petrowi* from pheasants in Nebraska. Males have curled tail. B. *Oxyspirura petrowi* in eye of dead pheasant.

mens examined is admittedly small, the information from them is broken down into percentage of infection per month in Table 1. More birds were examined during the winter months and these showed a 40 per cent incidence. The

TABLE 1.—THE RELATIONSHIP BETWEEN SEASONS AND THE AMOUNT OF PARASITISM BY *Oxyspirura petrowi*

Month	Number Pheasants	Number with Eyeworms	Per Cent with Eyeworms	Per Cent by Season
Jan.	2	1	50	
Feb.	24	13	54	40
Mar.	12	1	8	
Apr.	8	0	0	
May	6	2	33	25
June	2	2	100	
July	3	3	100	
Aug.	2	0	0	45
Sept.	6	2	33	
Oct.	0	0	0	
Nov.	4	3	75	75
Dec.	0	0	0	
Total	69	27	40	

lowest percentage, 25, was evident in the spring, increasing to 45 per cent in summer and 75 per cent in the fall. There was a ten per cent lower infection in birds collected from April through September than in those collected from October through March, 33 per cent and 43 per cent respectively.

It is possible that highway victims can not be considered a random sample of the population, but rather individuals handicapped by sore eyes. The average number of worms present in the eyes of infected birds was 2.0 in the right and 2.3 in the left. The parasitism ranged from only one in one eye to ten in each eye. Even in the heavily infected birds no exudate or macroscopic injury to the eye was noted. It would seem that eyes with large worms crawling about them would not function as well as normal eyes. Kobayashi (1927) reported considerable damage to the conjunctiva and ductus lacrymalis of chickens infected with *O. mansoni*. Twenty of 24 specimens examined in February were trapped at the Valentine Wildlife Refuge in the sandhills and they were as heavily parasitized as those from the highways.

Sanders (1928) demonstrated the life cycle of *O. mansoni* in chickens in Florida. He found that the developmental stages of the nematode occurred in the cockroach (*Pycnoscelus surinamensis*), and were released in the digestive tract of the chicken after the roach was eaten. The worms then migrated up the esophagus to the pharynx and through the naso-lacrimal duct to the eye, where they matured and mated. The female deposited eggs in the tear duct from where they were carried to the throat, swallowed and passed out in the feces, to be ingested later by roaches. The cycle required 50 to 100 days in the roach and 48 days in the chicken. Kobayashi (1927) found a similar life cycle for *O. mansoni* in Japan and Fielding (1926) for *O. parvovum* in Australia. The same species of roach served as the secondary host of both species of worm. Kobayashi found two moults of *O. mansoni* after the worm entered the eye, one at 3–5 days after infection and one at 15–19 days.

Similar studies of the parasite in Nebraska were not undertaken. In the main the life histories are probably similar, but it is doubtful if the secondary host could be a cockroach, since

TABLE 2.—NUMBER OF PHEASANT CROPS AND GIZZARDS EXAMINED AND THE PERCENTAGE HAVING INSECT REMAINS IN THEM

Month	Number Pheasants	Number Having Eaten Insects	Per Cent Containing Insects
Jan.	12	1	8
Feb.	55	10	18
Mar.	32	16	50
Apr.	26	20	77
May	15	11	73
June	4	2	50
July	24	16	66
Aug.	17	13	76
Sept.	24	15	62
Oct.	61	42	70
Nov.	26	16	61
Dec.	10	4	40
Total	306	166	54

this insect group is not prevalent in the sandhills.

There appeared to be a relationship between the amount of parasitism and the soil type or land usage. Of 49 pheasants collected in the sandhills 53 per cent were infected, while only 5 per cent of 20 collected from hardland cultivated areas showed parasites. Nine per cent of the birds taken in the summer from cultivated areas were parasitized, but none of those in the winter showed infestation. In the sandhills there was a 61 per cent summer infection and a 50 per cent winter infection.

If an arthropod is the intermediate host of this species and if an orthopteron is suspected, then a species or group avidly eaten by pheasants and generally distributed over their range could be expected to fulfill the host-parasite relationships necessary to bring about this high rate of infection. Two insects appeared regularly in the diet and made up a considerable proportion of the volume eaten. These were a bibionid fly larva, *Bibio* sp. and the grasshopper *Melanoplus mexicanus*. *Bibio* appeared in the diet from October through April and made up 5.76 per cent of the volume of food taken during these months. Its distribution was limited mainly to marsh areas of the sandhills. *Melanoplus mexicanus* appeared in the diet every month of the year but December and January and made up 4.67 per cent of the volume. It too was more commonly found in the

TABLE 3.—RELATIVE ABUNDANCE OF ARTHROPOD ITEMS IN THE DIET OF NEBRASKA PHEASANTS. FIGURES IN PERCENT, BASED UPON THE NUMBER OF CROPS CONTAINING ARTHROPOD MATERIAL

Group	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Aug.	Nov.	Dec.	Average
Orthoptera													
Acrididae		20	31	5	20		62	84	100	64	37		47
Gryllidae				5	9			15	13	12	6		7
Hemiptera	100	20	6	15	9	50	31	31	7	35	43	75	26
Coleoptera													
Carabidae and Tenebrionidae	100	60	62	70	81	50	50	46	47	35	37	50	51
Scarabeidae			6	15	30					2	6		5
Diptera													
Bibionidae	100	20	31	5						14	6	50	11
Others	100	10	12	5	38		12		7	16	6		12
Lepidoptera													
Noctuidae and Others	100	10	37	25	36	50	12	15	7	19	25	50	22
Hymenoptera													
Formicidae		10			20		6		13	24	18		18
Arachnida	100	30	25	35			38	15	13	14	18	75	15

diet of sandhill pheasants than in that of the hardland birds.

Although the pheasant is considered a granivorous species, insects have an important place in the diet. Table 2 lists the number of crops and gizzards examined and the percentages containing insects. From this it will be seen that 54 per cent of the birds had eaten insects prior to being killed. In Table 3 the kinds of arthropods taken are listed. Here the figures given are percentages indicating the number of times that insects appeared in crops and gizzards containing any animal matter. Grasshoppers appeared in 47 per cent of the specimens; as high as 100 per cent in September.

SUMMARY

The nematode eyeworm, *Oxyspirura petrowi*, was first noted in ring-necked pheasants of Nebraska in 1941. A study of highway killed and other accidental victims throughout north-central Nebraska showed a gross parasitism of 40 per cent. The number of worms per eye averaged two. Infection appeared to be greatest in the fall and was more closely associated with sandhills than with hardland soil types. As a possible lead to the biology of this parasite the entomophagus habits of the pheasant are discussed.

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BRIEFER ARTICLES

STARVATION OF PHEASANTS IN SOUTH DAKOTA

Unusually heavy snows during the winter of 1947–48 in north-central South Dakota made food inaccessible and resulted in the starvation of pheasants in some areas. Losses occurred in Campbell, Walworth, Edmunds and McPherson Counties where snow covered the ground from the first part of November to the latter part of March. Where there were large concentrations of pheasants, standing unpicked corn—practically the only food supply—was exhausted by the first of March and birds began dying from starvation.

About 100 dead birds were found in the vicinity of one pheasant concentration, and 44 dead and dying birds near another. Since these flocks contained an estimated 2,000 and 1,500 birds respectively, the mortality was only about 5 per cent. A thaw in mid-March uncovered food and alleviated a condition which, had it continued another week or two, could have resulted in heavy losses.

Birds weakened by starvation appeared listless, and were unable to fly or could make only short flights. When disturbed they would run a short distance, and then collapse. Poor control of the wing muscles was apparent (Plate 13, A). A male picked up alive and kept for several hours appeared drowsy and slept most of the time. Occasional light spasms were noticed in this bird.

The dead birds were found in or at the edge of roosting forms (Plate 13, B). Some died quietly in the forms while others seemed to have suffered a more violent death. They were found a few feet from the roosting form, their feet and heads outstreched.

Weights were obtained of 25 dead or dying pheasants, as well as of several apparently healthy birds from the same flocks. These data are compared with weights of normal birds in the following table:

TABLE 1.—WEIGHTS OF STARVED AND NORMAL PHEASANTS

Date	Area	Cocks			Hens		
		No.	Ave.	Wt.	No.	Ave.	Wt
March 13, 1948	Walworth & Edmunds Counties (Birds dead or dying)	6	23.6	oz.	19	19.2	oz.
March 13, 1948	Walworth & Edmunds Counties (Apparently healthy birds)	2	33.0	oz.	3*	23.9	oz.
Feb. 28, 1948	Sully County (Normal birds)	2	44.3	oz.	18	31.8	oz.

* Includes one hen which weighed only 19.7 oz.

These weight data suggest that the survival threshold was approximately 24 oz. for cocks and 19 oz. for hens, or 53 per cent and 60 per cent of their normal weights (Plate 13, C). The weight range was 1 lb. 9.2 oz. to 1 lb. 5.7 oz. for cocks, and from 1 lb. 7.4 oz. to 15 oz. for hens.

The sex ratio for the area affected, based on sight records and flushing counts, was about 75 cocks per 100 hens. Of the dead birds, however, over 75 per cent were hens, indicating that starvation affects them sooner than it does cocks. This is at variance with the conclusions reached by Latham (Jour. Wildlife Mgmt. 11(2): 139–149, April 1947). Perhaps the higher survival of cocks under natural conditions is a reflection of their greater ability to obtain food.

Extreme emaciation characterized all of 28 dead or nearly dead pheasants which were examined (Plate 13, D). The crops of most were empty and the gizzards contained only grit, fragments of corn stalks, straw, other cellulose material of low nutritional value,

PLATE 13

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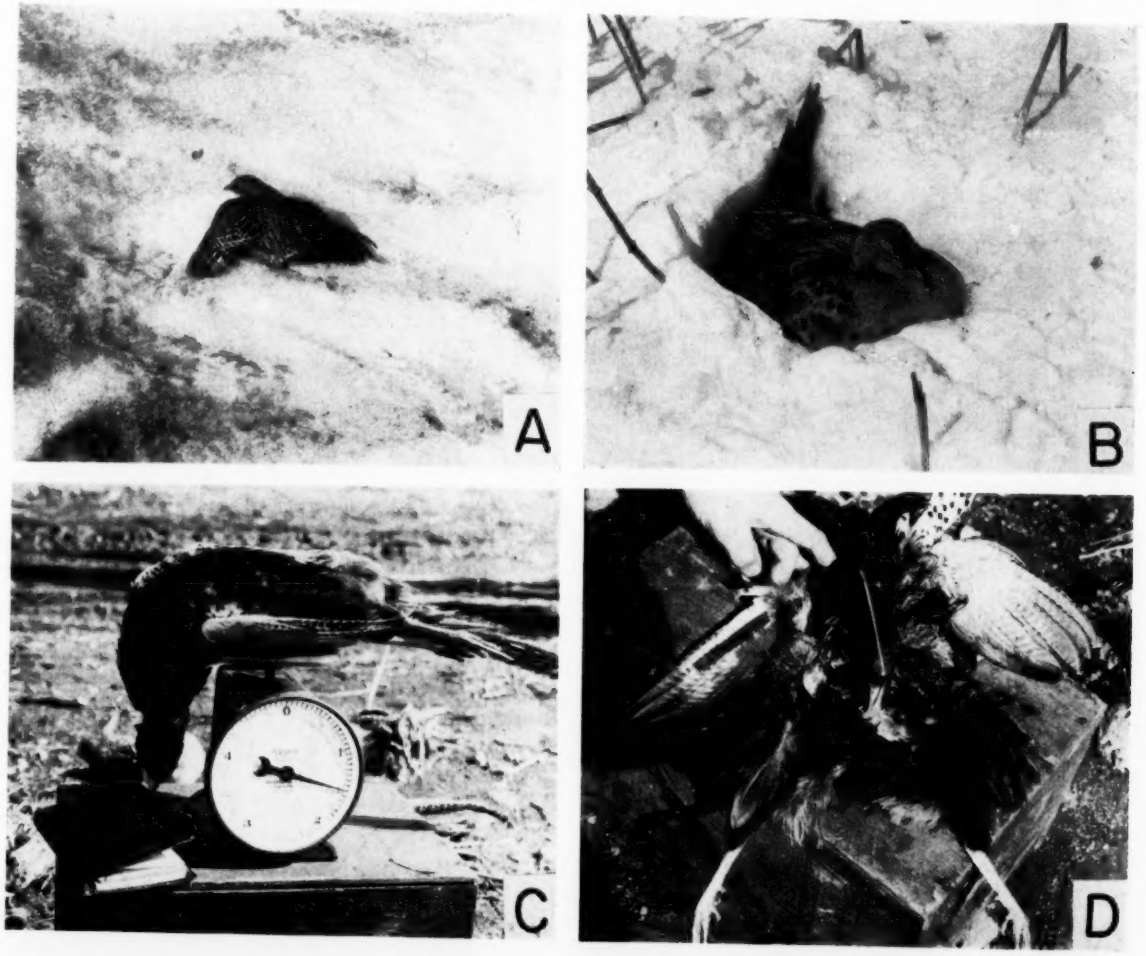

PLATE 13.—A. Hen pheasant weakened by starvation and unable to fly. B. Hen pheasant which died in roosting form. C. Cock pheasant which weighed 1½ lbs. when it died of starvation. D. Starvation loss showing emaciated condition.

and small amounts of manure. The crop of one dead hen was full of dry vegetation, and that of a dying hen full of wheat. Intestinal bleeding had occurred as a result of coarse material passing through the digestive tract. The gizzard linings of starved birds were dark green or black in comparison with the light green color of those in normal birds. The gonads appeared to be normal for the time of year.

Four birds, three cocks and one hen, were examined by the Department of Veterinary Medicine at South Dakota State College, and no evidence of disease found. Blood samples from two birds in weakened condition were negative for disease.

Some pheasants were supplementing their diets by feeding on carrion. Two hens, killed by cars, were found to have crops and gizzards full of pheasant flesh, feathers and bones, presumably obtained from other highway kills. These birds were well fleshed and in good condition. One hen pheasant was observed feeding on a mouse which had apparently been killed on the highway.—BERNARD A. NELSON and REUEL G. JANSON, *South Dakota Dept. of Game, Fish, and Parks, Pierre, S.D.*

A TRAPPING AND TAGGING TECHNIQUE FOR WILD FOXES*

Leopold (1933) has pointed out the desirability of tagging wild game mammals. Valuable information on movements, mortality, life span and populations may thus be attained. Cook (1943) described an achilles tendon band to tag foxes and other mammals. Errington and Berry (1937) have tagged foxes by the use of ear bands.

Properly applied, these methods may be satisfactory in tagging adult wild foxes. Tagging pups presents special difficulties. Several kinds of ear tags were tried on captive pups, but growing tissue eventually caused such irritation that the tags were often removed in one manner or another by the fox. The method described by Cook showed more promise although several recaptured fox pups had bad infections.

One disadvantage of either of the above methods is that small tags permit abbreviated instructions only; many hunters and trappers will not submit such tags. A few tendon bands were traced months after a fox was killed.

To compensate for these shortcomings a light spring metal collar was developed (Figure 1A). Several types of metals were used successfully. Any copper or brass noncorrosive alloy which has spring and is not brittle will suffice. Such a collar should be approximately a half inch wide and .016 of an inch thick weighing not more than half an ounce. Non-corrosive washers and split rivets (Figures 1B and 1C) complete the necessary equipment. The most difficult mechanical problem involved in the construction of the collar is the two inch slot which can only be successfully made by constructing a die and stamping the slots out on a punch press.

In preparation for application, the flat collar is wrapped around a cylinder of wood or metal. The smaller the cylinder the greater will be the eventual spring of the collar metal. The collars were adjusted in the field so that the spring caused a gentle pressure sufficient to close the slot on a small pup or keep it securely snug on an adult (Figures 1E and 1F). The slot is next to the neck; if it were on the outside there would be more danger of its becoming snagged. Two washers should be used, one next to the skin and one on the outside of the collar.

A pair of fur farm fox tongs facilitates handling live foxes. A loop of wire passed through a section of small pipe makes a fair substitute.

Of 22 returns received to date (July 1948), all the collars were in good shape, having apparently caused no discomfort. The longest record was a male gray fox banded as a pup in July of 1947 and killed in July of 1948.

The definite advantages of such a collar are: a) Immature foxes can be successfully banded; b) It is large enough to print detailed instructions; c) It is conspicuous enough to attract the attention of a hunter or

* Included in a thesis on fox research presented to the faculty of Cornell University in partial fulfillment of requirements for the degree of Doctor of Philosophy.

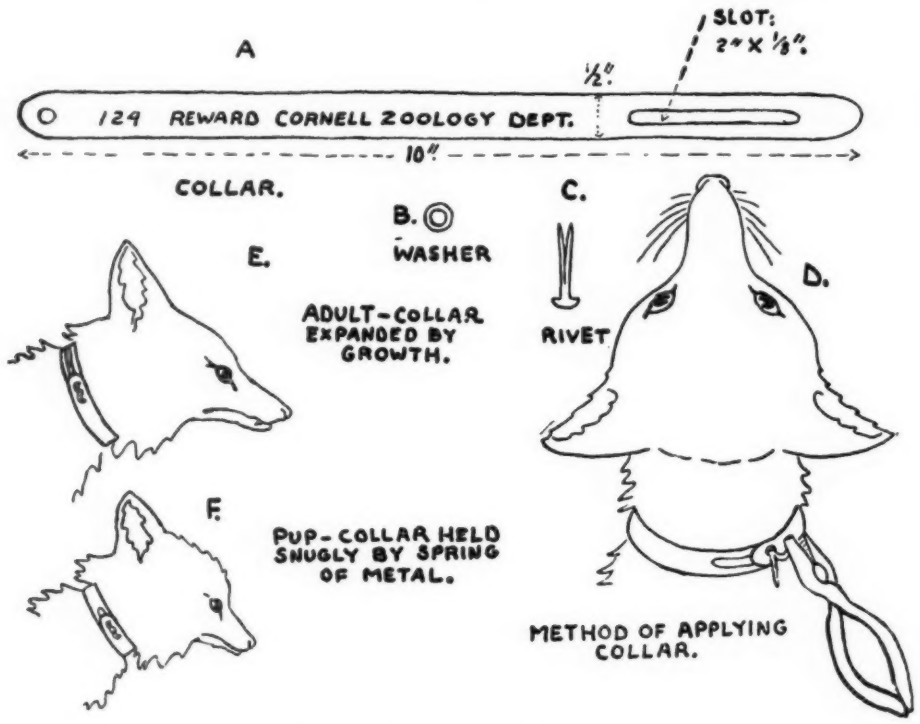

FIG. 1.—Application of Fox Collar.

trapper. Furthermore, it is believed that such a tag invariably elicited an inquiry; d) All the evidence indicated the collar does not interfere with the fox's normal behavior; e) Due to the head shape of the fox, it cannot be pulled over the head of even a young fox, and has little chance of snagging the animal; f) It can be observed from a considerable distance under field conditions.

After several experiments it was found that the only efficient manner to catch large numbers of foxes was to use a steel trap. Digging out dens is usually a long laborious process involving considerable expense and time with the added disadvantage that the habitat is spoiled. Thus, the best technique proved to be the setting of steel traps in hole entrances and runways around the dens or making scented dirt hole sets. This proved to yield more significant information than either direct observation or the reading of sign. The best pup trap was a no. 1½ double coil spring jump trap. One spring was removed and the jaws padded with adhesive tape. For adults, a no. 2 double coil spring standard fox trap proved most efficient. A fast trap is essential to catch adult foxes in dirt hole sets, so the removal of a spring usually results in a sprung trap. These traps were wrapped lightly with adhesive tape or set unpadded with the sharp edges of the jaws filed blunt.

In spite of many reports to the contrary, the average fox does not struggle much in a trap, particularly a trap heavy enough to tire the animal. Some adult vixens caught in no. 1 traps set in den runways were more likely to injure themselves than if caught in a no. 2 trap. The great majority of foxes caught in no. 2 traps were released unharmed. A few might be lame for two or three days but quickly recovered. No fox with a broken leg was released. Of 86 adults thus trapped, four were killed because of broken legs. of 65 pups trapped, seven had broken legs. A number of pups were recaptured twice and released un-

harmed. The 22 adult fox returns to date (July 1948) were all checked, and in each instance the fox's leg was reported completely healed. One fox was shot running in front of dogs five days after being trapped. Its gait seemed to be unimpaired. Another adult was retrapped 12 days after first capture, and its foot was entirely healed. However, trapping with steel traps for the purposes of releasing foxes in the wild should cease with the advent of heavy frosts since a fox with a frozen foot would in most cases become permanently maimed.

Usually traps set at a red fox den cause abandonment of the den; accordingly this method was not used in some dens which were under direct observation. In the one gray fox den that was repeatedly trapped, the foxes persisted in returning. Individuals were retaken even when released some distance away.

ACKNOWLEDGMENTS

I am indebted to Dr. W. J. Hamilton, Jr. for helpful advice. Credit is due The New York Conservation Council for a grant financing research on foxes in New York State. W. J. Schaldach, Jr. drew the figures included.—WILLIAM G. SHELDON, *Department of Forestry and Wildlife Management, University of Massachusetts, Amherst, Mass.*

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METHODS OF ESTIMATING POCKET GOPHER POPULATIONS

Various methods of measuring the relative abundance of small mammals have been suggested and applied to many species, but little has been done with pocket gophers and other fossorial mammals. The problem undertaken here was the practicability of a method previously used in estimating gopher populations and to try another method of censusing found to be successful with other kinds of animals.

The pocket gopher studied by us is the foothill race, *Thomomys bottae mewa* which ranges along the west side of the Sierra Nevada mountains in the Digger Pine Belt. The area selected for the investigation is located in a hog-wallow prairie immediately north of the junction of the Kern-Friant canal and state highway 168, northeast of Clovis, Fresno County, California. The soil type as given by Holmes (1919) is San Joaquin sandy loam. Two permanently uncultivated circular areas of one acre each were selected for study. Circular areas are more satisfactory for such a study because the smaller perimeter introduces less error caused by animals moving onto the study plot (Stickel, 1946). All of the gophers were trapped off a buffer strip fifty feet wide around each plot at the same time they were trapped on the plot. Plot A was located on an area that had not been grazed for two years. It was covered with considerably more low-growing vegetation and relatively fewer surface gopher workings than was plot B only sixty yards away. Plot B was across a fence and was a part of an area that has been heavily grazed continuously. Two kinds of traps were used, the well-known Macabee gopher trap and a live trap somewhat similar to that described by Scheffer (1934). The study period extended from February 14 to May 15, 1948. While set the traps were visited every 4.5 hours and because of these frequent visits, trap-hours rather than trap-nights were used as a unit. A total of 1,187 trap-hours were used in the investigation.

The strip-counting method used by Davis and his colleagues (1938) and which was found by them to be satisfactory on areas with small populations was found to be inapplicable here because the sets of "runs" were very close to each other and it was impossible to tell where one set left off and another began. Even in Plot A which con-

TABLE 1.—THE ESTIMATED AND ACTUAL POPULATIONS OF POCKET GOPHERS ON PLOTS A AND B

	C	M	N	Estimated population per acre	Actual population per acre
Plot A	5	3	5	8.3	11
Plot B	7	0	5	—	20

C = Adult gophers taken and marked during first period of live trapping.
M = Marked adult gophers taken in the second trapping period.
N = Total adult gophers taken in second trapping period.

tained less than a dozen adult gophers, we could not with certainty delimit the extent of any single run of burrows. In Plot B there was no indication on the surface whatever of the ranges of individuals. We, therefore, question the accuracy of this method and the results summarized by Mohr (1947) in which densities as high as 15 gophers per acre are reported.

The population index used so successfully with other animals (Lincoln, 1930, birds; Green and Evans, 1940, snowshoe hares; and Burt 1946, *Peromyscus*) was also tried. Each plot was divided into quadrants each of which was continuously trapped with nine live traps baited with rolled oats for a period of 4.5 hours. The traps were set only at fresh workings. Each plot was therefore continuously trapped for two 9-hour days or 162 trap hours. All adult gophers caught were toe marked and released into the same burrow from which they were taken. After a two-week interval the plots were trapped again using the same time interval and the same number of traps. The study plots were then trapped with a saturation number of Macabee traps until all of the gophers were removed from the plot. This required 539 trap hours. The results are shown in Table 1. The actual populations per acre were 11 on the ungrazed plot and 20 on the grazed plot.

It is evident that this index is not adequate in estimating these gopher populations because not enough of the total populations were caught in the short periods of time and as a result the error is so great as to invalidate the index. A longer trapping time is also impractical because the trap hours required for the complete removal of the animals would be less than the number of trap hours given to testing the index. Ten weeks after the end of the study there was no evidence that the pocket gophers had moved across the buffer strips and onto the inner acres studied.—LLOYD G. INGLES, RONALD CLOTHIER, and LOUIS A. CRAWFORD, *Fresno State College, Fresno, Calif.*

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OBSERVATIONS OF MOOSE COURTING BEHAVIOR

On September 25, 1947, J. E. Gaab and Robert Neal, Fieldmen of the Montana Wildlife Restoration Division made the following observations of moose courting behavior in the Absaroka Wilderness Area. The moose did not appear to notice the observers.

A mature bull moose was observed pawing in a small area at the base of a rock cliff near the outer margin of a forested area. After a few strokes of pawing, he straddled the depression, bent his body near the ground and urinated into the hole he had pawed out. The bull carried out the alternate operation of pawing and urinating seven times before a female moose appeared from the adjacent timber. As the cow approached, the male moose padded the wallow with a downward motion of his forefeet. He then laid in the wallow and twisted and turned, presumably to cover his body with mud.

When the cow reached the area, she struck the bull with a front foot until he got out of the wallow. The female then laid down and rolled and turned, covering herself with mud. The bull standing by during this procedure, came toward the cow and struck her with a front hoof. When both animals were standing, the bull smelled the female genital region and began rubbing his neck and bell along her back and sides. The cow stood facing away and while the bull continued this action she stamped her rear legs and tossed her head.

When this activity had nearly ceased the cow started to walk away several times, but was stopped each time by a low grunting call from the bull. Finally they walked together into the forested area. Coitus was not executed at this time.

Close examination of the wallow was made after the departure of the moose. A round depression thirty-six inches in diameter and eight inches deep made up the wallow. The soil was damp and had a sparse grass covering. A musky-urine odor prevailed in the area. Two similar wallows were found at distances of thirty and fifty yards from the original wallow.—W. K. THOMPSON, *Montana State Fish and Game Dept., Helena, Mont.*

PREDATION ON ANTELOPE

Several observations of predator activities on pronghorn antelope were made in 1947 and 1948 during the trapping and censusing activities of the Wildlife Restoration Division of the Montana State Fish and Game Department.

On January 28, 1948, while counting antelope in Carter County, Pilot-Biologist Don Brown and I noted a band of 64 antelope running toward the airplane and apparently not frightened by it. At the rear of the herd an adult golden eagle was flying, just behind the last antelope. The eagle suddenly seized the last antelope, a mature male, on either side of the backbone and rode with outspread wings for about 100 yards. It then released its hold and flew behind for a short distance and again grasped the buck. This was repeated three times. The last time we flew down to attempt a picture and the eagle left its prey. Upon regaining altitude we noticed another eagle pursuing a band of nine antelope and the first eagle circled to resume chasing the larger band.

This observation substantiated, in part, the reports of actual observations of golden eagles killing antelope by grasping them along the back and riding with out-spread wings until the antelope collapsed.

We tracked an antelope for over three miles and large flecks of blood marked the trail in the snow. The marks of a large bird, apparently an eagle, were observed in the snow from which we concluded that the bird had landed several times during the chase. The path taken by this animal was meandering in a general northerly direction. There were no indications of the animal seeking protection of coulees, fences or shrubbery. Apparently flight is over the open rolling plains were the greatest speed can be made.

During the aerial census eagles were seen feeding on two antelope carcasses; a fresh snow may have covered additional evidence.

Forty-seven golden eagles and three bald eagles were observed during 31 hours of census strip flying.

In August, 1947, Deputy Raleigh Shields on aerial patrol in Musselshell County, watched a golden eagle kill an immature antelope. The eagle first attacked the young animal by grasping it near the small of the back and spreading its wings, making it difficult for the fawn to run. Upon circling a second time with the airplane, he observed that the eagle had the antelope grasped by the throat and ribs, but both were on the ground and the antelope appeared to be on top. At the time of a third circle, the eagle was eating from the hams of the antelope. All efforts to frighten the eagle by diving with the plane were unsuccessful.

Trapping Foreman Bill Koch and Pilot Cliff McBratney reported observations of coyote predation upon antelope during trapping operations. On January 2, 1947, these men and the Restoration Division trapping crew were operating south of Shawmut, Montana. A band of 40 pronghorns was being driven into the trapping area when two coyotes cut into the herd at 11:30 a.m. One of the coyotes grabbed a mature doe by the throat and the other one grasped her high on a hind leg. They pulled the antelope to the ground and were feeding upon her before the plane could circle to drive them off. Of interest was the fact that the antelope had been herded through this area before. It was open with little shrubbery and the coyotes completely disregarded the airplane.

On January 4 in the same area a single coyote broke into another band of antelope being herded by the airplane and pulled another female antelope to the ground. The men succeeded in driving the coyote away by firing revolvers from the airplane. The doe resumed flight with the herd and was trapped. No evidence of injury by the coyote was found on the captured antelope. These observations were reported to a coyote hunter in the area and he shot six coyotes within one-quarter mile of the antelope trap.—W. K. THOMPSON, *Montana Fish and Game Dept., Helena, Mont.*

DEER FORAGE OBSERVATIONS IN UTAH[1]

During the summer and early fall of 1947 a study of deer food habits was made on an area of the Uinta National Forest, Utah. The study area had been closed to livestock grazing for a number of years and attempts had been made to reseed some of the larger, non-wooded openings at the higher elevations.

The vegetal types consisted mainly of oak, maple, and aspen with a few small, scattered stands of spruce-fir on the north-facing slopes.

The oak type which occupied the lower portion of the area was characterized by very extensive, dense patches of gambel oak (*Quercus gambeli*) interspersed with sagebrush (*Artemisia tridentata*), mulesears (*Wyethia amplexicaulis*), aster (*Aster* sp.), and sweetvetch (*Hedysarum boreale*). The grasses were represented mainly by bluebunch wheatgrass (*Agropyron spicatum*). In many places the thick oak so effectively occupied the area that there was no understory.

At the intermediate elevation, oak gave way to bigtooth maple (*Acer grandidentatum*). The maple type included large volumes of chokecherry (*Prunus virginiana melanocarpa*), ninebark (*Physocarpus malvaceus*), Engelmann aster (*Aster engelmanni*), nigger-head (*Rudbeckia occidentalis*), Solomonplume (*Smilacina racemosa*), mountain brome (*Bromus carinatus*), and wildrye (*Elymus* sp.)

The aspen of the upper portion of the area furnished very little forage because the old trees had grown out of reach of grazing animals and reproduction was sparse. The aspen understory consisted mainly of maple, snowberry (*Symphoricarpos* sp.), elderberry (*Sambucus* sp.), goldeneye (*Viguiera multiflora*), mullein (*Verbascum thapsus*), nigger-head, butterweed groundsel (*Senecio serra*),

[1] It should be emphasized that this study was conducted in Pole and Rock Canyons near Provo, Utah, and that the findings may not have wider application than the immediate study area.

TABLE 1.—SUMMER AND EARLY FALL FOODS OF MULE DEER IN UTAH

Species	Average of all types in which species occurred	
	Percent of total vegetation	Percent utilized
Forbs		
Solomonplume (*Smilacina racemosa*)	2	46
Engelmann aster (*Aster engelmanni*)	3	31
Aster (*Aster* sp.)	4	6
Lettuce (*Lactuca serriola*)	Trace	8
Salsify (*Tragopogon dubius*)	Trace	5
American vetch (*Vicia americana*)	1	4
Bluntseed sweetroot (*Osmorhiza obtusa*)	3	2
Mulesears (*Wyethia amplexicaulis*)	21	2
Shrubs		
Rose (*Rosa* sp.)	Trace	22
Elderberry (*Sambucus* spp.)	1	7
Chokecherry (*Prunus* sp.)	4	1
Ninebark (*Physocarpus malvaceus*)	3	1

mountain brome, and bluegrass (*Poa* spp.).

Weight and utilization of herbage were estimated by species on permanent plots located within each vegetal type. In every type, the weight of available browse produced exceeded that of forbs. Only in the maple type did the weight of grass produced exceed that of forbs.

Utilization in general was extremely light. Of the estimated total volume of forage available, less than 2 percent was used. The use of grass was so light that it was recorded only as a trace. Of the total volume of forage used in all types, forbs made up the greatest part by far, more than tripling the volume of browse used. This was true regardless of the proportionate amounts of the three classes available for forage.

The most preferred species, in the order of their preference are listed in Table 1.

Other species which were not abundant enough on the permanent plots to warrant specific conclusion but whose high preference rating has been indicated by general observations are lambsquarter goosefoot (*Chenopodium album*), white polemonium (*Polemonium albiflorum*), alpine phacelia (*Phacelia alpina*), violet (*Viola* spp.), white and yellow sweetclover (*Melilotus* spp.), valerian (*Valeriana occidentalis*), and wildcabbage (*Caulanthus crassicaulis*). The berries of *Smilacina racemosa* seem to be particularly relished. Oak showed a low average percent utilization, but because of its abundance it made up a large proportion of the total browse consumed in the oak type. The openings in the aspen type, where reseeding had been attempted, were covered almost entirely with tarweed (*Madia glomerata*) except for a few rocky patches that supported rose bushes. The tarweed was not touched by deer, but the rose was utilized wherever it occurred.

Observations made after forbs and grass had dried showed no apparent increase in the use of browse in the aspen type in the fall. In the maple type, use of browse increased from 2 pounds per acre in August to 25 pounds per acre by the middle of October.—JUSTIN G. SMITH, *Intermountain Forest and Range Experiment Station, Ogden, Utah.*

A REPORT ON RECHECKING CERTAIN IDAHO STREAMS IN THE AREA TREATED FOR TUSSOCK MOTH

Early in July 1948, one year following the DDT treatment of the area for Tussock Moth eradication, a search for aquatic organisms was made in certain streams of the Idaho area described by Adams et. al. earlier in this issue.

Unfortunately circumstances prevented an exact correlation between this check and work done by Mr. Hanavan at the time of the spraying project. It is recognized that certain inconsistencies will appear, due to the differences in methods employed and places checked. It is felt, however, that the following information indicates a definite trend. Each location was checked three times.

Immediately following the DDT treatment in this area a check was made on the stomach content of trout, *Salvelinus fontinalis*. The results of these findings are included in Mr. Hanavan's report. A recheck in July 1948, was attempted but no fish were taken. Apparently the fish population in this stream has decreased considerably.

It is concluded from the above observations that the situation with respect to fish feed has changed during the past year. Only further study will determine the seriousness of this problem and what remedial steps should be taken.—TIM M. VAUGHAN, *Biologist, Idaho Dept. Fish and Game.*

WATER CHECKED	LOCATION	AQUATIC ORGANISMS FOUND
Mannering Creek	T42N. R3W. Sec. 12	(1) Neg. (2) 1 stone fly nymph, 1 midge (3) Neg.
E. F. Meadow Creek	T42N. R3W. Sec. 13	(1) 1 May fly nymph (2) Neg. (3) 2 midges
W. F. Meadow Creek	T42N. R3W. Sec. 23	(1) Neg. (2) Neg. (3) Neg.
Jerome Creek	T42N. R3W. Sec. 33	(1) 1 Crayfish (2) Neg. (3) 2 midges, 2 mayfly nymph, 1 stonefly
S. F. Palouse River	T42N. R3W. Sec. 36	(1) Neg. (2) Neg. (3) 2 Mayfly nymphs
Palouse River	T41N. R3W. Sec. 8	(1) Neg. (2) Neg. (3) Neg.
Boulder Creek	T39N. R2W. Sec. 18	(1) Neg. (2) Neg. (3) Neg.

NOTES ON THE EFFECT OF AIRCRAFT-DISTRIBUTED DDT-OIL SPRAY UPON CERTAIN PHILIPPINE FISHES

Although many published reports have described the lethal effects of DDT sprays upon North American fishes, few of these reports have been concerned with the death of a species under field conditions whose mortality resulted in large financial loss to private individuals. That this is not the case in other parts of the world was brought forcefully to mind when extensive mortality of DDT-sprayed fishes was reported from the important milkfish industry in the Philippine Islands.

Such losses occurred in an area north of Manila in 1946 as a result of routine malaria control measures carried out by the U.S. Air Force. The DDT was introduced into the milkfish ponds as an aerial spray from C-46 type aircraft equipped with a gravity-feed spray boom installation. The spray was a 5 percent DDT solution in fuel oil. The concentration per unit of area is unknown, but due to the type of equipment used, is presumed to be high and probably in excess of 0.2 lbs per acre.

In June 1947 with Mr. Heracleo Montalban, Chief of the Division of Biology of the Philippine Bureau of Fisheries, the writer visited one of the pond systems where high mortality of the young milkfish had occurred following spray treatment several months previously. Through Mr. Montalban's interpretative efforts the foreman of the ponds described some of the details of the spray effects. The pond in which the greatest mortality occurred was about one-half hectare (1.2 acres) in size and contained water approximately 6 inches in depth. This pond was stocked with some 120,000 fingerlings which averaged two inches in length. Shortly after the spray plane passed, the foreman noticed that some of the fishes in this pond seemed to be acting strangely, and soon it was evident that a number of them would die. With the idea that he might save some of the fish, the foreman then flooded the pond with water, raising the level to twelve inches. This he believed helped to cut down the rate of mortality. However, despite this action, at least 50 per cent of the fish in the pond did not survive. With fingerlings of two inches length being valued at 300 to 400 pesos per 10,000, this loss has a monetary value of about 1,800 pesos (900.00 dollars U.S.). Because of the objections of the owners of the ponds to the spray treatment, no further malaria control by aircraft was conducted in this area.

The above 50 percent loss is roughly in agreement with results which the writer obtained in open Florida ponds using a B-25 with carefully calibrated constant-flow spray equipment. Here it was found that the mortality rate would be highest among small fishes in shallow areas. Those forms which fed at the surface were usually most affected, and those which fed at the bottom and in midwater, the least. Milkfish fingerlings are mostly herbivorous, feeding principally on bottom and surface algae and associated organisms. When these fishes are disturbed, they are commonly given to the habit of jumping from the water. Such factors should bring a large number of these fish into contact with any DDT oil film which might fall upon the surface of the pond.

Technical personnel from the Philippine Malaria Field Laboratory located at Tala, Bulacan Province, some 28 kilometers north of Manila have described to the writer the lethal effects of aircraft-distributed DDT sprays upon the fresh water fishes of that region. Notable in this particular situation was the use of the DDT-killed fishes (chiefly *Ophiocephalus*, also known as snakehead or mudfish) for food by the local residents. No ill effects were reported or observed as the result of ingestion of this contaminated food. On the other hand certain aquatic vertebrates such as snakes are well known for the tremors and often death which result from such feeding.

Details of field and laboratory experience gained by the military forces upon the effects of DDT solutions upon wildlife, as well as Air Force methods in insecticide dispersal, are available in the three unrestricted military reports listed below. These reports in published or manuscript form may be obtained by research agencies upon application to the Commanding General, Air Force Proving Ground Command (Attention: Chief, Proof Test Section) Eglin Field, Florida:

Geary, John M. 1947. Developmental Test of Water dispersible DDT spray equipmen—AAF Proving Ground Project 3-46-36 (Incl. 7 contains an account of laboratory tests conducted by Lt. Michael Korzenovsky on the mosquito fish *Gambusia affinis holbrooki* as affected by dispersible and other DDT formulations (7 pp. and 25 tables).

Herald, Earl S. 1946. Suitability of the R-6 helicopter for dissemination of insecticides. AAF Board Rept. E-4839, (reports little effect upon game fishes in spray tests on the St. John's River, Florida).

Sullivan, W. N. 1946. DDT dissemination of exhaust generated spray. AAF. Board Rept. 4670B725 (Incl. 10 contains DDT bird toxicity field studies by Mr. Roger Tory Peterson and Dr. George Sutton, and toxicity studies on cold-blooded vertebrates by the writer (172–215). (18 pp. and 14 tables.)

EARL S. HERALD

Curator of Aquatic Biology, Steinhart Aquarium, California Academy of Sciences, Golden Gate Park, San Francisco, California (Former military assignment with the Army Air Force Committee on Aerial Dispersal of Insecticides, AAF Proving Ground Command, Orlando, Florida).

REVIEW

Trout Fisheries in New Zealand—Their Development and Management by Derisley F. Hobbs. New Zealand Marine Dept. Fish. Bull. 9 Wellington, N. Z. 175 pp. Appen. A-E, illus. 1948. 4s.

This publication is a very comprehensive work on trout in New Zealand. Beginning with the early development of the trout fishery between 1865 and 1875—the formation of "acclimatization societies" and the construction of hatcheries—the author follows the development of the fishery up to the present. He describes the main trout rivers and the effects of erosion, water diversion and dam construction on the trout habitat and concludes that "there is no evidence which suggests that through the country generally in the last sixty years there has been any progressive deterioration in the capacity of most waters to produce trout." Records of angling clubs and individual fishermen indicate some reduction in the average size of the trout taken, from shortly after the initial period of stocking up until 1900. Since that time the average size in most streams has remained fairly constant. In many streams the average weights of trouts have exceeded one pound from 1890 up until 1945. Apparently big trout are not unusual in New Zealand, for records from nine acclimatization districts, 1932–1942, show *average* trout weight figures ranging from 0.68 pound to 4.63 pounds each; the average weight for trout from all nine districts was 1.89 pounds.

Perhaps the most interesting part of this bulletin is the discussion of hatchery costs and inefficiency as compared with the best information available on natural reproduction. "The evidence as to quantities of eggs handled in hatcheries (New Zealand), in relation to total quantities produced naturally, clearly shows that the former quantity is of almost negligible significance in relation to the latter. This is so, even though a major portion of funds available for maintenance of stocks is already being expended on hatchery work." ". . . The number of fry released per angler each year would usually be much the same as that produced by the natural spawning of a pair of fish of 2 or 3 pounds alone." After reviewing pertinent data published in the U. S. and Canada on the survival of stocked trout, and comparing these data with less complete information from New Zealand, the author concludes: "Revenue arises substantially from the licensing of exploitation of stocks which are produced naturally. It cannot be invested in artificial stocking with the expectation of accomplishing more than small increases, in a few places where conditions favor survival exceptionally. This is so irrespective of the size to which fish are grown before their release."

In the latter part of the book (p. 110) the author discusses the problem of future management of the trout resource. Although trout stocking has increased with the increase of the fishery during the past 40 years, this practice has fallen so far behind in the number of fry stocked as related to the yield of adult trout that it cannot make even a minor contribution to improvement of the fishery. The author concludes that there is need for only a few hatcheries, these to produce fry for stocking lakes where natural spawning areas are inadequate, and streams that are subject to severe scouring by floods during the period when trout spawn. New Zealand's pollution laws are antiquated and should be brought up to date to control the industrial wastes dumped in some streams.

The main fish predator of trout is the long-finned eel (*Anguilla dieffenbachii*); the short-finned eel seems to be less important because of its smaller size. Eels may be controlled by denying their access to trout waters, by making waterfalls inaccessible to young eels, by trapping elvers as they travel inland and by trapping young eels during the secondary migrations. Adult eels are easily taken in baited traps.

Three species of cormorants (shags) occur on inland waters of New Zealand. Of these, only the "large black shag" (*Phalacrocorax carbo*) is important as a trout predator because of its size and fish-eating habits. "On present evidence the control of this species on inland waters containing trout is justified."

Hobbs concludes that although fishing pressure has increased greatly in the past 40 years, there is no evidence that the highest level of production has been reached or that the fishery is deteriorating. "Conservation, in its best sense, means such management as makes possible the highest continuing rate of exploitation. There is a danger of a defeatist or negative interpretation being placed on this term, and of the word being used to justify such inefficient management as contemplates nothing more than progressive increase of restrictive regulations and progressive increase in license fees, to be spent on measures which offer as little hope for the future as they have in the past."

In the management of the New Zealand trout fishery "the interests of anglers would be better served in the future if priority were given to three measures which must be basic to the intelligent utilization of the fisheries."

"These are:

(1) Adequate protection of spawning fish.
(2) Prevention of loss of fish in drought-stricken areas.
(3) So regulating lawful exploitation that sufficient fish survive to make the maximum efficient use of spawning grounds."

Many fisheries administrators confronted with the headaches associated with trout stream management in the United States will conclude that New Zealand has no trout problem.

In the reviewer's opinion, *Trout Fisheries in New Zealand* is a fine example of comprehensive research of the extensive type, in which the author has made full use of his own and others intensive research to arrive at certain logical conclusions.—GEORGE W. BENNETT.

THE WILDLIFE SOCIETY

Report of the Secretary as of February 20, 1949

Since its formation, the Wildlife Society has enjoyed continuous and rapid growth. The 636 members and subscribers in 1938 were nearly doubled at the time of the Pearl Harbor attack. Though membership diminished slightly from 1942 to 1945, during the post-war years memberships and subscriptions have increased nearly an additional 50 per cent above earlier high levels. A table summarizing this growth is included in this report. The Society can well be proud not only of its vigorous membership, but particularly of its Journal and Newsletter which, guided by their editors, have reached all-time levels of production and prestige.

As of February 20, the Society rolls listed 523 active and 679 associate members who have paid their 1949 dues. Above this total of 1,220, there are 7 honorary and 6 life members. Additionally, a great many of the 90 active and 165 associate members of 1948 who have not yet submitted their 1949 fees certainly will retain their memberships through late payments.

Since our last business meeting in April 1948, the Membership Committee and the Council have approved 53 members for active status. The applications for active status of 18 other members are now pending. During the past ten and a half months, 166 new associate members were welcomed into the Society. The following are the new active members:

Lowell Adams	Frank C. Craighead
George N. Alpaugh	John J. Craighead
Harry G. Anderson	T. Stuart Critcher
Robert O. Beatty	David E. Davis
Glenn L. Bowers	Robert R. Elliott
W. J. Breckenridge	W. Harry Everhart
La Verne Brugger	William A. Fuller
C. Edward Carlson	Bryan P. Glass
Thomas G. Clark	Frederick Greeley
Archibald Cowan	Roy A. Grizzell

Growth of the Wildlife Society, 1938–49 as Revealed by the Annual Reports of the Secretary and Treasurer

	Active[1] Members	Associate[1] Members	Subscribers[1]	Total[2]	Receipts[3]
1938	—	—	32	636	$2,370
1939	303	470	80	853	3,459
1940	360	545	135	1,040	3,891
1941	359	570	171	1,100	3,733
1942	375[4]	528[4]	189	1,092[4]	5,506
1943	250[5]	350[5]	130[5]	730[5]	3,284
1944	354	457	184	995	4,279
1945	453	545	217	1,219	6,148
1946	451	577	211[4]	1,246	6,504
1947	536	640	—	1,400 ±	6,253
1948	577	713	287	1,592	7,605
1949	613	862	282	1,770	9,088

[1] Including delinquents of one year as of date of reports.
[2] Including Life and Honorary Members as well as delinquents of one year.
[3] Including back issue sales.
[4] Not including delinquents.
[5] Estimated from receipts.

Ralph F. Honess
Robley W. Hunt
Gilbert N. Hunter
W. C. Jacobsen
Herbert E. Johnson
Raymon E. Johnson
Paul T. Kreager
J. Burton Lauckhart
Karl C. Leebrick, Jr.
Ralph A. MacMullen
Robert A. McCabe
George W. McCullough
Charles L. McLaughlin
Henry E. Predmore, Jr.
William L. Reaveley
Maurice C. Reeves
Vincent H. Reid
Tudor Richards
Francis B. Schuler
William G. Sheldon
Harold R. Shepherd
W. F. Sigler
Curtis K. Skinner
J. Donald Smith
Milton H. Stenlund
Harry Stroebe, Jr.
Donald R. Thompson
Herbert S. Wallace
Orthello L. Wallis
Olaf C. Wallmo
Cecil S. Williams

Since last April 4, the Secretary regrets to report that notices of the deaths of five members have been received. Professor Aldo Leopold, who must be called the father of scientific game management, passed away on April 21, 1948. On October 17, E. Sidney Stephens, the well-known Missouri conservationist, died. Like Professor Leopold, Mr. Stephens was one of the few men elected to Honorary Membership in the Society. William C. Adams, popular game administrator of New York, reached the end of a vigorous and useful life on August 8, 1948. George B. Lay of Massachusetts is reported to have died on May 6, 1948. Harry Van Cleve of Pennsylvania passed away during the past year.

Resignations were submitted by: Stephen G. Baldwin, E. W. Callenbach, Robert S. Campbell, C. A. Darling, Anton M. Decker, F. M. Frederiksen, Robert D. Hostetter, Lee O. Hunt, Raymond D. Knox, Robert N. Lake Allan R. Phillips, Willis H. Rich, and Jerry E. Stillwell.

Among subscribers, 165 have paid for 1949 while 117 have not yet renewed their subscriptions. Most of the latter group, however, may be expected to eventually continue their subscriptions. Many foreign subscriptions take the Journal into far corners of the world: Alaska, Canada, Mexico, Brazil, England, France, Denmark, Sweden, the U.S.S.R., Tanganyika, Ivory Coast, Union of South Africa, Philippine Islands, New Zealand and Australia are the countries currently represented.

Two new Sections were formed within the Society. The formation of the Northern Rocky Mountain Section and the Southeastern Section were approved by the Council on May 1 and July 19, respectively.

As a result of popular acclaim, on June 23, Warren W. Chase was appointed Representative for Region III by the Council. This action followed the resignation of Walter A. Gresh, who moved from that Region.

On March 25, the Society became incorporated as a non-profit scientific organization in the District of Columbia. Logan Bennett, Gustav Swanson, Leo Couch, and C. R. Gutermuth were instrumental in arranging for this long-overlooked matter.

By mail ballot, changes in the Constitution were proposed which provided (1) that Honorary Members might vote and hold office, (2) that Life Members might be elected by the Council, and (3) that the rule permitting ex-servicemen to purchase wartime issues at a reduced rate expire December 31, 1950. These proposals were overwhelmingly acceptable to the members who voted but they failed of passage because of the failure of two-thirds of the active members to return marked ballots.

The Society contributed $50.00 to-

ward the support of the Inter-American Conference on Renewable Natural Resources which was held in Denver in June. The "Hoover Commission" investigating the Executive branch of the government solicited the opinion of the Society on the operation of agencies concerned with wildlife and was given a suitable report.

The annual List of Members and the constitution were prepared and published in the Journal. Notices to delinquent members were prepared and mailed on two occasions during the past year.

The routine business of the Society has continued to be large in volume. In addition to regular record-keeping, it is estimated that a minimum of 2,000 letters have been received and answered by the Secretary during the past year. If replies to correspondence have sometimes been delayed longer than would be desirable, it has been only because of the combined pressure of official and Society business on already overworked office staffs.

The Secretary wishes to thank all of the officers, Council members, Committees, the editor and all members for their constant and friendly cooperation during the past year. He regrets, however, that he will be unable to accept the renomination offered him by the Society. He is especially indebted to his wife and to the office staffs of the Ohio and Texas Wildlife Research Units for their more-than-generous assistance.

Respectfully submitted,
GEORGE A. PETRIDES, *Secretary*

REPORT OF THE TREASURER

Receipts		
Balance Dec. 31, 1947		$ 9,101.88
Receipts, dues, subscriptions, dividends & interest		8,830.65
TOTAL INCOME		$17,932.53
Disbursements		
Stationery & Printing	$ 208.81	
Postage, telegrams	159.08	
Express	1.37	
Office Equipment	6.75	
Clerical Assistance	94.30	
Editor's Expense	—	
Treas. Fidelity Bond	12.50	
Indexing Journal Wildlife Management	70.65	
Bank Charges (returned checks)	40.33	
Conference expense	26.83	
Insurance, Journal Stock	27.33	
Contributions	100.00	
Miscellaneous	5.00	
TOTAL	752.95	
Journal of Wildlife Management	$ 5,571.74*	
Newsletter	803.26	
Reprints	11.39	
TOTAL	$ 6,386.39	
22 shares, State St., Investment Trust	979.00	
10 shares, Loomis-Sayles Mutual Fund	992.70	
2—500 Series G, U. S. Government Bonds	1,000.00	
TOTAL	$ 2,971.70	
GRAND TOTAL		$10,111.04
BALANCE IN BANK, Dec. 31, 1948		$ 7,821.49

PAUL D. DALKE, *Treasurer*

* Included is the amount $181.12 reimbursed to Journal budget for over-run on one article.

REPORT OF THE EDITOR

Journal of Wildlife Management

January 1 to December 31, 1948

The year reported on herein has been characterized by the usual excellent cooperation on the part of the membership and the officers of the Society. The editor's job has not been an onerous one, but the numerous time demands on him have made it essential that he resign from his editorial duties to allow him to apply himself to his own official responsibilities.

There is but one primary difficulty relating to the Journal—one of financing—which is not insurmountable, but which will require some attention and planning on the part of the Council. An idea of the growth of the Journal can be obtained from the following tabulation:

	Year	*Volume*	*Pages*	*Total Pages*
	1937	1	107	107
	1938	2	278	278
McAtee	1939	3	370	370
	1940	4	452	452
	1941	5	472+x	482
	—1942	6	363+vii	370
	1943	7	428+iv	432
Storer	1944	8	348+xxii	370
	1945	9	336+xxiii	359
	—1946	10	376+xxvii	403
Mills	1947	11	367+xxxi	398
	—1948	12	448+xxxi	479

After the war-period slump, which was not apparent in the Journal of Wildlife Management so much as in some other journals, 1948 represented the largest year's contribution since pre-war 1941, the only volume which exceeded it in number of pages. At the present time there is a great abundance of manuscript material on hand and regularly more contributions are being received. The Journal, then, is growing and there is no dearth of manuscript on hand for future publication.

On the other hand, Volume 12 was the most costly one to date—well over $5,000. This represented an overdraft of around $600 on the budget of $4,800 approved in March, 1948. A few weeks after the approval of the 1948 budget, the publishers found it necessary to increase their charges and a new contract was approved by the President. This advance in costs was essential if we were to have publication continuity, but it threw the financing out of line.

The Council approved, in 1948, the publication of long articles if over run were charged to the author. Rules governing this were that a maximum of 20 pages be allowed any one article, and beyond that all pages including tables and plates be charged for at the rate of $10.50 per page. This cost was arrived at by dividing the total pages in Volume

11 by the total cost. It is now too low, the per-page cost coming closer to $11.50. On the basis of this Council action, one long paper appeared in 1948 which netted the Society $226.80. This income should be credited to the Journal cost and should reduce the overdraft in the budget by that amount.

The Council also approved, in 1948, the immediate printing of papers if the author assumed *all* costs, provided that the papers thus given priority meet the the usual standards and that the volume be increased to that extent. This action was later rescinded, and no papers were printed on this basis. Such prior publication is common procedure in other journals, allows for timely appearance of material, and does not militate against the appearance of regular contributions. Rather, it increases the size of the Journal at no cost to the Society.

I would recommend for action of the Council the following:

1. Increase the Journal budget to $5,800. (Approved by Council. Ed.)
2. The prior printing of articles if the author pays *all* costs incident thereto, if the papers are of the usual Journal standard, and if the size of the volume is increased for their inclusion. (No action. Ed.)
3. The editor's work is no small task, and it now is a contribution of his time, skill, and effort for the good of the Society. This should be recognized in some way, possibly by the Society's assumption of his expenses to the North American Wildlife conference, or the awarding of a life membership to him as he assumes his duties. I can say this in all fairness for I am suggesting no retroactive clause. (To Finance Committee. Ed.)

A few remarks are desirable concerning Volume 13, the current one. No. 1 is the largest single number to appear to date—144 pages. This came about because of the mass of manuscript material on hand and the inclusion of another over-length paper. Over-length charges have been received and transmitted to the treasurer. This should be credited against the 1949 costs. No. 2 has gone to the printer. It has one and possibly two over-length articles in it, but should print out approximately 100 pages. The present editor will follow it through, after which the new editor takes over.

The retiring editor has nothing but praise for the Society's officers and members. They have been kind concerning his faults, and most helpful in many ways. Relationships with the printers have been most cordial, and he commends them for their businesslike but personal handling of Journal problems. He is sure that the same excellent working contacts will be extended to the incoming editor.

Respectfully submitted,
HARLOW B. MILLS

REPORT OF THE BUSINESS MEETING OF THE COUNCIL

The Council convened at 7:30 P.M. on March 6, 1949, at the Hotel Statler, Washington, D. C. Council Members Tracy I. Storer, Ian McT. Cowan, George A. Petrides, Paul D. Dalke, Allan T. Studholme, Warren W. Chase

E. R. Kalmbach, Walter P. Taylor and C.H.D. Clarke were present.

W. L. McAtee was unanimously renominated as Trustee.

Three vacancies in the Membership Committee will be created by the expiration of the terms of office of P. F. English, D. I. Rasmussen, and Richard B. Miller. The Council acted to nominate William E. Ricker, now on the committee, to be chairman, and Paul Dalke, Paul Needham and Phil Goodrum to fill the vacancies soon to occur. The Council acknowledged the great debt of the Society to Dr. English, who has served on this committee for six years, to Mr. Rasmussen, who for four years has thus served the Society, and Mr. Miller, who has served for two years.

In view of his eminence in the fields of ecology and mammalogy, the Council voted unanimously to recommend Charles Elton, Director of the Bureau of Animal Population, Oxford, England, for Honorary Membership. The Council expressed the opinion that the Society should adopt a policy of confining the number of honorary members to an indefinite but a low figure.

Because of his long service and the pressure of other duties, Paul Dalke has found it necessary to resign as Treasurer of the Society. The Council expressed for the Society its appreciation for the services of Dr. Dalke during the past three years. In accordance with provisions of the Constitution Maurice Baker of Missouri was appointed to fill the remaining portion of Dr. Dalke's term.

The resignation of Harlow B. Mills as Editor was accepted with reluctance. It was unanimously agreed that a public expression of gratitude for Dr. Mill's work be made for the Society by the Council. Gustav A. Swanson was appointed as the new Editor. A motion was made and carried that the 1949 budget for the Journal be increased from $5,300 to $5,800. The Editor was given authority to set the costs of overrun articles which are to be paid by authors. An earlier decision was reaffirmed rejecting the prior publication of articles paid for entirely by an author.

The proposed 1949 budget was presented by Treasurer Dalke and approved by the Council. The possibility of combining the Newsletter and Journal was considered but a decision was postponed. It was unanimously agreed that the Finance Committee be instructed to (1) investigate for early report the desirability of investing a larger proportion of the Society's bank balance, and (2) appraise the entire financial structure of the Society to determine the prospects for providing financial assistance to the Secretary, Treasurer, and Editor. It was voted unanimously to accept the report of the Auditing Committee, which consisted of a C.P.A. audit of the Treasurer's records.

The matter of membership classes was discussed with divided opinions being expressed. A motion was made and carried that the Professional Standards Committee be instructed to prepare a statement and ballot for inclusion in the Newsletter which will review the situation and will poll the entire membership to determine its reaction to one versus two principal membership classes. The Committee's report is to be reviewed by the Council before publication.

A proposal to provide free subscriptions of the Journal to European libraries was defeated, with the opinion being that such cases may be cared for through individual donations. The Council voted to encourage the publication of letters to the Editor, and other discussions of a thought-provoking nature, in the Journal or Newsletter.

A Resolutions Committee consisting of Dr. Warren W. Chase, Chairman, and Dr. Durward Allen was appointed.

The meeting adjourned at 11:15 P.M.

TRACY I. STORER, *President*
GEORGE A. PETRIDES, *Secretary*

MINUTES OF THE ANNUAL MEETING OF THE WILDLIFE SOCIETY

The thirteenth annual meeting of the Society was called to order by President Tracy I. Storer at 8:00 P.M., March 7, 1949 at the Hotel Statler, Washington, D. C. About 200 people were in attendance.

Reading of the minutes of the 1948 meeting was dispensed with since they were printed in the Journal of July, 1948. The report of the meeting of the Council on March 6 was read. It is published in this issue of the Journal.

The nomination of Professor Charles Elton, Director of the Bureau of Animal Population Oxford, England, as Honorary Member was unanimously endorsed by the Society in recognition of his established eminence in the field of vertebrate ecology.

W. L. McAtee was unanimously reelected to the position of Trustee. The Council action in nominating William E. Ricker as Chairman of the Membership Committee and Paul D. Dalke, Phil D. Goodrum, and Paul R. Needham to fill the vacancies on this committee was ratified.

The Secretary's report was read and accepted and the Society graciously expressed its appreciation for the Secretary's efforts in office.

Harlow B. Mills tendered his resignation as Editor of the Journal of Wildlife Management. It was accepted with reluctance. Dr. Mills labored hard and well and the Journal has prospered during his term of service. Gustav A. Swanson was appointed the new Editor.

The Treasurer's report was read and accepted. Paul D. Dalke's announcement of his resignation as Treasurer was received regretfully as the Society has benefited greatly during his three-year term of office. His resignation was accepted after expressions of appreciation for his good work. The investments held by the Society were reviewed briefly and President Storer elaborated on the Council action to initiate a thorough study of the status of the Society's funds and of its ability to undertake new financial responsibilities in connection with support of the Secretary, Treasurer, Editor, and other activities.

For Region I, Representative Allan T. Studholme and Philip Barske reported on a two-day meeting of members on March 5 at College Park, Maryland. Sixty-five members were in attendance at a panel discussion on farm game problems led by Durward Allen. The Northeast Section of the Society elected the following new officers: *President*, Ben Bradley (New York), *Vice-presidents*, Frank C. Edminster (Pennsylvania) and Harry A. Goodwin

(Massachusetts), *Secretary*, Philip Barske (Connecticut).

A new Section was organized in Region II according to the report of Clarence Watson, who was elected president. Twenty-five new members were gained for the Society in the southeast region during the past year. Henry Mosby announced that two meetings of the Virginia Section had been held.

Warren W. Chase, Council Member for Region III, commented on the continued high numbers of Society members in the midwest. The Midwest Wildlife Conference was held at Ann Arbor, Michigan, on December 9, 10, and 11. The transactions of this highly successful meeting were mimeographed by the Michigan Department of Conservation. John Moyle, of the Minnesota Section, stated that 14 monthly meetings have been held in St. Paul and that group has grown from 22 to 52 members. At the request of the Governor, they are now preparing recommendations for a game and fish management policy for Minnesota.

In Region IV, E. R. Kalmbach reported a recent joint meeting of foresters, range managers and wildlife biologists at Denver. A dozen or more Society members were present. At the International Conference on the Conservation of Renewable Resources held last June at Denver, several Society members held positions of importance.

Walter P. Taylor, Region, V, acknowledged the services of F. M. Baumgartner, Charles T. Vorhies, W. C. Glazener and Levon Lee in serving the Society as sub-representatives in the four large southwestern states. In Oklahoma, a Game and Fish Council was organized to assist the Army Corps of Engineers in studying the biology of impounded waters. Members of the Society in Texas and Oklahoma met with the Academies of Science in their respective states.

No report was made for Region VI. Paul D. Dalke advised that the Northern Rocky Mountain Section has been active, and more than 100 members are listed.

C. H. D. Clarke reported for Canada, Region VII. Membership there has increased rapidly during the year. A waterfowl personnel meeting in September may become an annual event. Annual meetings of the federal and provincial wildlife officials, the Canadian Society of Forest Engineers, the Fisheries Research Council, and the Ontario Research Council were held to consider wildlife values and problems.

P. F. English, Chairman of the Membership Committee, reported on the continued vigor of that group. All members were urged to assist the Society by securing new members.

After a consideration of publications appearing during 1948 in the field of wildlife ecology and management, the Awards Committee designated "The Pronghorn Antelope" by Arthur S. Einarsen as the winner of the Society's award certificate for the past year. As a result of productive activity of Chairman Durward L. Allen, and his committee, attractive certificates were prepared for all past winners of this award. Oscar Warbach generously prepared the original copy of the award, which is suitable for framing.

The Awards Committee polled many members to determine the best way in which the Society could provide appro-

priate recognition for the profession's greatest leader: Aldo Leopold. The Society enthusiastically and unanimously adopted the Committee's recommendations that a Leopold Memorial Medal be created and struck in bronze. It will be awarded annually, according to the decision of a committee appointed by the President, to a single individual for "service to wildlife conservation." Any living person will be eligible to receive this medal, but no award will be made in years when the committee finds no deserving candidate. The project has the written approval of the Leopold family. It will involve an original expense of about $1,000 and an annual cost of about $30. It was decided that a Leopold Memorial Committee should be appointed to complete the project during the coming year and that the Committee with the President, Secretary and Dr. A. Starker Leopold will give final approval of the design and financial arrangements.

R. M. Rutherford, Chairman of the Employment Committee, reported that his group has assisted persons of known experience who were seeking new positions. The Committee has had no requests, however, for recent graduates with no experience and has no facilities for large-scale service as an employment agency. A survey of the states revealed only one in which employment regulations entirely forbid the hiring of out-of-state residents.

The Professional Standards Committee, Ralph T. King, Chairman, prepared an extensive report summarizing earlier recommendations and suggestions pertaining to professional standards in the wildlife management field. Jobs which have been completed establish standards for (1) active membership in the Society, (2) publication, (3) academic training, and (4) civil service positions. Some major problems needing further attention include: (1) job analysis for the guidance of students and schools, (2) accrediting of schools and agreement on standardization of curricula, (3) agreement on subject matter, for Civil Service examinations, and (4) establishment of a code of ethics. Projects which involve no particular cost have been done; the expensive problems remain. The report is to be studied by the next Finance Committee as a portion of its overall survey of Society needs.

Chairman Warren W. Chase of the Committee on Wildlife Nomenclature reported that his committee had listed some of the terms which cause confusion and had established a basis for completing their assignment to assist in their standardization. He recommended reappointment of the Committee to complete the work by the spring of 1950. W. L. McAtee summarized activities of the Committee on Memorials since 1946. Sketches of the lives of 15 deceased members have been prepared.

The Editor of the Newsletter, Henry S. Mosby, reported that four issues per year are planned and requested items for publication. The Committee concerned with indexing the Journal was reported by C. A. Dambach to have completed its task. The manuscript will shortly be available for publication.

The Resolutions Committee (W. W. Chase and Durward Allen) offered the sincere thanks of the Society to C. R. Gutermuth and the Wildlife Management Institute for their very successful efforts in conducting the Fourteenth

North American Wildlife Conference. The efforts of the Society's officers and editorial staff also were praised by that committee with the unanimous approval of the Society.

Suggestions for improving future meetings were (1) providing a table at the Conference to recruit new members, (2) holding the business meeting on Sunday night rather than during the Conference, and (3) streamlining the order of business.

The meeting was adjourned at 11:15 P.M.

TRACY I. STORER, *President*
GEORGE A. PETRIDES, *Secretary*

SPECIAL REPORT OF THE AWARDS COMMITTEE

Many members of this Society have expressed themselves as being in favor of the establishment of an award to honor the late Aldo Leopold. The feeling is undoubtedly general that there should be an appropriate recognition of the debt this profession owes to its greatest leader.

A year ago President Storer suggested that the Awards Committee formulate a plan for such an award in order that the Wildlife Society might act upon it at this meeting. The Chairman has corresponded with most of the officers and committee members of the Society and has solicited opinions from nearly everyone with whom he had personal contact.

Sentiment in this organization appears to favor action along several well-defined lines. It is recommended that the Society consider each of the following points, and after necessary decisions have been made, the project can be completed in the coming year.

1. It is recommended that a Leopold Memorial Medal be created bearing a profile in relief and an appropriate inscription. This medal would be struck in bronze and would be approximately 2½ inches in diameter.

2. This medal would be awarded annually according to the decision of a committee appointed by the President except that no award would be made in those years when the committee decided that there was no deserving candidate for this honor.

3. The Leopold Memorial Medal would be given to a single individual for "service to wildlife conservation." The Leopold Memorial Committee would decide what constituted such service.

4. Any living person would be eligible to receive this medal.

This project has received the written approval of the Leopold family. To determine approximate costs, a profile photograph and a tentative design were sent to the Medallic Art Company, 325 E. 45th St., New York City. On this basis an estimate was made that the art work would cost approximately $800. The making of the dies would cost approximately $200 more. Striking off the medal in bronze each year and doing the necessary engraving would cost approximately $30, which would include the cost of a case for attractive presentation. If the work is done by this company, the total initial cost of the medal would run somewhat more than $1,000.00.

There is a possibility that the art work might be done by some sculptor friendly to the Society who would be

willing to give us a special price. Inquiries have been made to this end but nothing definite has yet been obtained.

It is suggested that if the Society approves this medal a Leopold Memorial Committee should be appointed and authorized to incur the necessary expense to have the project completed during the coming year, it being understood that the work would be done to the greatest advantage of the Society consistent with high quality results.

It is further suggested that the Memorial Committee plus the President and Secretary of the Society and Dr. A. Starker Leopold be authorized to give final approval to the design and financial arrangements for the medal.

Respectfully submitted
EDWARD C. RANEY
DAVID E. DAVIS
DURWARD L. ALLEN, *Chairman*

REPORT OF BALLOT COMMITTEE

The Committee audited the nomination and election ballots for The Wildlife Society for 1949–50 and found the following:

1. *Nomination Ballots.* Nominated for *President:* Clarence Cottam and Ian McT. Cowan; *Vice-President:* Samuel A. Graham and E. R. Kalmbach; *Secretary:* Shaler E. Aldous and Irven O. Buss; and *Regional Representatives: Region 1:* Allan T. Studholme and Durward L. Allen; *Region 2:* Clarence W. Watson and Leonard E. Foote; *Region 3:* Warren W. Chase and Thomas R. Evans; *Region 4:* E. R. Kalmbach and J. W. Kimball; *Region 5:* W. P. Taylor, W. B. Davis, and W. C. Glazener; *Region 6:* A. S. Leopold and J. W. Moffet; *Region 7:* C. H. D. Clarke, A. W. F. Banfield, and I. McT. Cowan.

2. *Election Ballots.* Results: *President* Clarence Cottam; *Vice-President:* E. R. Kalmbach; *Secretary:* Shaler E. Aldous; and *Regional Representatives: Region 1:* Durward L. Allen; *Region 2:* Clarence W. Watson; *Region 3:* Warren W. Chase; *Region 4:* J. W. Kimball; *Region 5:* William B. Davis; *Region 6:* A. Starker Leopold; *Region 7:* C. H. D. Clarke.

We find the above correct and final as of April 16, 1949.

RICHARD CALLENDER
LEONARD W. WING
WENDELL SWANK
W. B. DAVIS, *Chairman*